EXHIBIT 11

$MOG PAPER – 1.0

BE A FUCKING WINNER.

WIN AT EVERYTHING YOU DO.

- END -

EXHIBIT 12

MARKET CAP
$1,224,059,987

SPOT VOLUME (24h)
$113,122,223

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MOG COIN
$0.000003134

About $MOG | Memes | Merch | How To Buy | How to Bridge | Mog Me

$MOG™

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//// ALWAYS BE MOGGING //// MOG IS THE TICKER //// MOG IS TOKENIZED WINNING //// WIN AT EV

WTF IS MOG?

$MOG is the internet's first culture coin.

But it's more than just a coin, it's tokenized winning. $MOG is effortless cosmic domination and unadulterated success distilled into computer photons, wrapped into erc- 20 tokens, and placed directly on the Ethereum blockchain. Mog is a movement, it is a way of life. Since day one, Mog has built its community organically from the ground-up with one goal in mind: to be a culture-defining force in the crypto ecosystem.

Ethereum Mainnet CA:
0xaaee1a9723aadb7afa2810263653a34ba2c21c7a

Base CA:
0×2da56acb9ea78330f947bd57c54119debda7af71

MORE ABOUT $MOG

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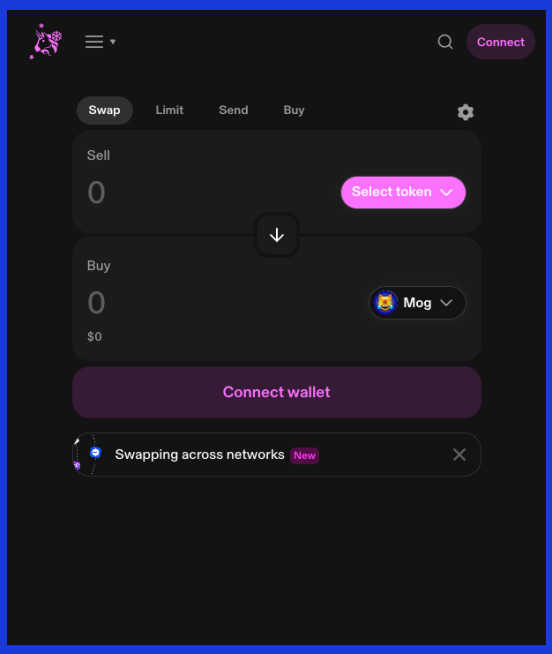

LEGAL DISCLAIMER: $MOG is a crypto coin with no intrinsic value or expectation of financial return. Just because some people are getting ridiculously rich buying crypto doesn't mean you definitely will. MOG is to be used strictly for getting laid and for entertainment purposes only.

Etherscan CoinMarketCap

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Gate HTX Uniswap Aerodrome DexScreener Dextools

BASE

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The first ever culture coin is now available on BASE L2.

0x2Da56AcB9Ea78330f947bD57C54119Debda7AF71

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EXHIBIT 13

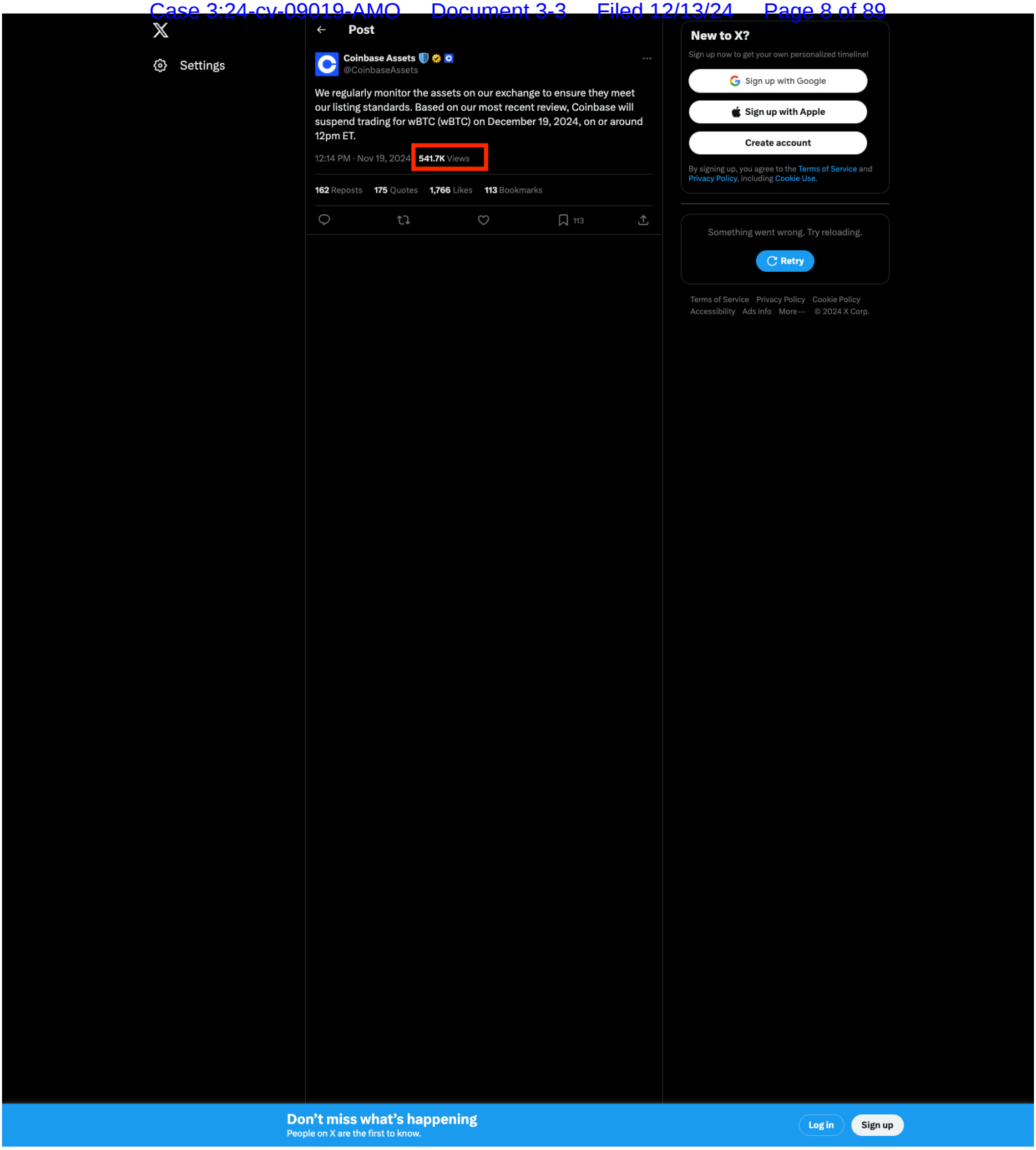
Settings
Post
Coinbase Assets
@CoinbaseAssets
We regularly monitor the assets on our exchange to ensure they meet our listing standards. Based on our most recent review, Coinbase will suspend trading for wBTC (wBTC) on December 19, 2024, on or around 12pm ET.
12:14 PM · Nov 19, 2024 541.7K Views
162 Reposts 175 Quotes 1,766 Likes 113 Bookmarks
113
New to X?
Sign up now to get your own personalized timeline!
Sign up with Google
Sign up with Apple
Create account
By signing up, you agree to the Terms of Service and Privacy Policy, including Cookie Use.
Something went wrong. Try reloading.
Retry
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EXHIBIT 14

cbBTC whitepaper

What is cbBTC?

Coinbase Wrapped BTC ("cbBTC") is a token that is backed 1:1 by native Bitcoin (BTC) held by Coinbase, meaning that for all cbBTC in circulation, there is an equivalent amount of BTC held in a secure custody solution (including cold storage) provided by Coinbase. Wrapped assets, like cbBTC, are transferable tokens that are redeemable for the underlying asset. Coinbase customers can unwrap cbBTC and redeem a corresponding amount of the underlying BTC simply by depositing the cbBTC into their Coinbase accounts. cbBTC is built to be seamlessly compatible with DeFi applications, giving customers the option to tap into DeFi and unlock financial utility.

Why cbBTC?

cbBTC removes a key point of friction by allowing customers to use Bitcoin they already hold in new ways onchain. cbBTC is built to be seamlessly compatible with DeFi applications, so users can now tap into novel DeFi use cases like providing their Bitcoin as liquidity to DeFi protocols, using it as collateral to borrow other crypto assets, or spending it as a payment method. Wrapped assets like cbBTC are a mature concept in the crypto world, helping to bring more liquid assets onchain and facilitate an expansive financial ecosystem.

Minting and Burning Process

cbBTC is fungible 1:1 with a dedicated reserve of BTC held at Coinbase. The process of minting (sending) and burning (redeeming) cbBTC ensures trust and transparency, providing a frictionless experience for users. When a user requests a withdrawal of cbBTC, Coinbase holds the corresponding amount of BTC in its custody to back the cbBTC minted.

- **Minting**: When a user initiates a withdrawal of BTC held in their Coinbase account to the Ethereum,Base or Solana networks, an equivalent amount of cbBTC is minted on the network and sent to the user's destination address / wallet.
- **Burning**: When cbBTC is deposited to a user-specific Coinbase address, the cbBTC is burned and the corresponding amount of BTC is released from Coinbase's reserve and assigned to the user's Bitcoin account.

The total supply of cbBTC can be found in the token smart contract under totalSupply (Base, Ethereum, Solana).

On EVM chains, the process of minting and burning cbBTC involves using a set of audited and secure smart contracts. These contracts are designed to mint and burn cbBTC as needed,

ensuring that the total supply of cbBTC always matches the amount of BTC held backing it. cbBTC is built using the core elements of the Coinbase wrapped token contract that was also used for Coinbase Wrapped Staked ETH (cbETH). The smart contract code open source repository for Coinbase's wrapped tokens – including both cbBTC and cbETH – can be found on Github.

The following are key roles of the wrapping contract managed by Coinbase. These roles are protected by Coinbase's key management systems and usage requires approval from a number of people in different functions, including security, engineering, and finance.

- Admin: can upgrade the wrapped token implementation contract
- Owner: can assign all roles except the Admin
- Blacklister: can blacklist an address from transferring, minting, and burning
- MasterMinter: can assign minters and their limits
- Minter: can mint and burn tokens
- Pauser: can pause transfers, mints, and burns for the contract

On Solana, cbBTC is an SPL token. Coinbase manages and controls the mint and burn cbBTC as needed, ensuring that the total supply of cbBTC always matches the amount of BTC held backing it.

The following key authorities of the SPL token are owned and managed by Coinbase. These roles are protected by Coinbase's key management systems and usage requires approval from a number of people in different functions, including security, engineering, and finance.

- Mint Authority: can mint tokens
- Freeze Authority: can pause/unpause transfers to/from specified addresses
- Update Authority: can update token metadata

Security Measures & Compliance

Coinbase employs state-of-the-art wallets, regular audits, and comprehensive monitoring systems to safeguard the BTC backing cbBTC. Additionally, all smart contracts involved in the minting and redemption process are rigorously tested and audited by third-party security experts.

Coinbase engaged OpenZeppelin in an audit of the cbETH Solidity smart contract contract (link) which was also used for cbBTC. No material contract code has been modified in deploying cbBTC.

Custodianship and Governance

The underlying BTC reserves backing cbBTC are held 1:1 at Coinbase, and redemption rights remain with cbBTC holders. Please reference the applicable Coinbase User Agreement to learn more about Coinbase's custodial services and terms specific to users holding cbBTC.

Coinbase utilizes both hot wallets and cold wallets in its custodial solutions. Cold wallet private key materials are stored and secured at facilities within the United States and Europe. As part of Coinbase's risk mitigation efforts, wallet private keys are not stored in plaintext format in any location and the cryptographic consensus of multiple human operators is required to decrypt a private key for both hot and cold wallets. No single individual has control of Coinbase's wallet private keys. Coinbase performs internal audits of the private key management process and reconciliations between Coinbase wallets and third-party blockchain data. Coinbase does not use sub-custodians in connection with the storage of digital assets.

Regulatory Compliance

Coinbase is committed to operating within the legal frameworks of the jurisdictions in which it operates. The launch of cbBTC will comply with all relevant regulations, including Anti-Money Laundering (AML) and Know Your Customer (KYC) requirements. Coinbase has obtained numerous licenses to operate in the United States and internationally, including multi-state money transmission licenses, and crypto asset trading and custody licenses in New York, Germany, Singapore, Canada, Bermuda, and more. Coinbase is also a registered Virtual Asset Service Provider in a number of countries.

Risks

Smart contract security risk
cbBTC is at its core a smart contract, and with that comes risk that the code may be exploited in unforeseen ways. This risk is partially mitigated by the fact that the foundation of cbBTC is based on heavily audited and battle tested smart contracts (like USDC and cbETH).

External cbBTC price risk

The price of cbBTC onchain will be determined by the individual markets and is not pegged or in any other way maintained by Coinbase. As with any asset trading in free markets, there is always some degree of price risk inherent in the trading of cbBTC in relation to BTC on other markets.

Fees

There are no fees associated with minting/wrapping or burning/unwrapping cbBTC today. Users will be charged network fees for withdrawals from Coinbase.

EXHIBIT 15

Policy Statement Regarding the Scope of Unfair Methods of Competition Under Section 5 of the Federal Trade Commission Act
Commission File No. P221202

November 10, 2022

Section 5 of the Federal Trade Commission Act (FTC Act) prohibits "unfair methods of competition in or affecting commerce."[1] On July 1, 2021, the Federal Trade Commission (FTC) rescinded its 2015 Statement of Enforcement Principles Regarding "Unfair Methods of Competition" under Section 5 of the FTC Act.[2] This statement supersedes all prior FTC policy statements and advisory guidance on the scope and meaning of unfair methods of competition under Section 5 of the FTC Act.

I. Introduction

Pursuant to the FTC's analysis of the decided cases and prior enforcement actions, this policy statement describes the key principles of general applicability concerning whether conduct is an unfair method of competition. Consistent with the Supreme Court's interpretation of the FTC Act in at least twelve decisions, this statement makes clear that Section 5 reaches beyond the Sherman and Clayton Acts to encompass various types of unfair conduct that tend to negatively affect competitive conditions.[3]

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[1] Pub. L. No. 63-203, 38 Stat. 717; 15 U.S.C. § 45(a)(1).

[2] Fed. Trade Comm'n, Statement of the Commission on the Withdrawal of the Statement of Enforcement Principles Regarding "Unfair Methods of Competition" Under Section 5 of the FTC Act (July 9, 2021), https://www.ftc.gov/legal-library/browse/statement-commission-withdrawal-statement-enforcement-principles-regarding-unfair-methods.

[3] *See, e.g. Fed. Trade Comm'n v. Ind. Fed'n of Dentists*, 476 U.S. 447, 454 (1986) (holding that "[t]he standard of "unfairness" under the FTC Act is, by necessity, an elusive one, encompassing not only practices that violate the Sherman Act and the other antitrust laws"); *Fed. Trade Comm'n v. Sperry & Hutchinson Co.*, 405 U.S. 233, 242 (1972) (holding that "the Commission has broad powers to declare trade practices unfair."); *Fed. Trade Comm'n v. Texaco*, 393 U.S. 223, 262 (1968) (holding that "[i]n large measure the task of defining "unfair methods of competition" was left to the [FTC]. . . and that the legislative history shows that Congress concluded that the best check on unfair competition would be [a practical and expert administrative body] . . . [that applies] the rule enacted by Congress to particular business situations"); *Fed. Trade Comm'n v. Brown Shoe*, 384 U.S. 316, 321 (1966) (holding that the FTC "has broad powers to declare trade practices unfair[,] particularly . . . with regard to trade practices which conflict with the basic policies of the Sherman and Clayton Acts"); *Atlantic Refining Co. v. Fed. Trade Comm'n,* 381 U.S. 357, 369 (1965) (holding that all that is necessary is to discover conduct that runs counter to the public policy declared in the Act. . ." and that "there are many unfair methods of competition that do not assume the proportions of antitrust violations"); *Fed. Trade Comm'n v. Colgate-Palmolive et al*., 380 U.S. 377, 384-85 (1965) (noting that the proscriptions in section 5 are flexible); *PAN AM v. United States*, 371 U.S. 296, 306 -308 (1963) ("[Section 5] was designed to bolster and strengthen antitrust enforcement[,] and the definitions are not limited to precise practices that can readily be catalogued. They take their meaning from the facts of each case and the impact of particular practices on competition and monopoly"); *Fed. Trade Comm'n v. Nat'l Lead Co*., 352 U.S. 419, 428-29 (1957) (affirming past rulings finding that the commission is clothed with "wide discretion in. . . [bringing] an end to the unfair practices found to exist[;]. . . [is] 'the expert body to determine what remedy is necessary to eliminate the unfair or deceptive trade practices which have been disclosed[;] . . . has wide latitude for

This statement is intended to assist the public, business community, and antitrust practitioners by laying out the key general principles that apply to whether business practices constitute unfair methods of competition under Section 5 of the FTC Act. In considering whether conduct, either in a specific instance or as a category, constitutes an unfair method of competition, the Commission will directly consult applicable law. This statement does not pertain to any other statutory provision within the FTC's jurisdiction.[4]

II. Background and Legislative History of Section 5 of the FTC Act

A. The text, structure, and legislative history of Section 5 show that its mandate extends beyond the Sherman and Clayton Acts and reaches unfair conduct with a tendency to negatively affect competitive conditions

As the Commission explained in its July 2021 withdrawal of the previous policy statement, the text, structure, and history of Section 5 reaches more broadly than the antitrust laws.[5] Congress passed the FTC Act to push back against the judiciary's adoption and use of the open-ended rule of reason for analyzing Sherman Act claims,[6] which it feared would deliver inconsistent and unpredictable results and "substitute the court in the place of Congress."[7]

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judgment and[;]. . . [that] to attain the objectives Congress envisioned, [the FTC] cannot be required to confine its road block to the narrow lane the transgressor has traveled"); *American Airlines, Inc. v. North American Airlines, Inc*., 351 U.S. 79, 85 (1956) (finding that "[u]nfair or deceptive practices or unfair methods of competition". . . are broader concepts than the common-law idea of unfair competition"); *Fed. Trade Comm'n v. Motion Picture Advertising Service Co*., 344 U.S. 392, 394-95 (1953) (noting that "Congress advisedly left the concept [of unfair methods of competition] flexible . . . [and] designed it to supplement and bolster the Sherman Act and the Clayton Act[,] [so as] to stop . . . acts and practices [in their incipiency] which, when full blown, would violate those Acts[,]. . . as well as to condemn as "unfair methods of competition" existing violations of them"); *Fed. Trade Comm'n v. Cement Institute*, 333 U.S. 683, 708 (1948) (holding that conduct that falls short of violating the Sherman Act may violate Section 5); *Fed. Trade Comm'n v. R. F. Keppel & Bro., Inc.*, 291 U.S. 304, 310 (1934) (finding that unfair methods of competition not limited to those "which are forbidden at common law or which are likely to grow into violations of the Sherman Act").

[4] This statement does not address the Commission's authority to prevent unfair or deceptive acts or practices in 15 U.S.C. §§ 45(a),(n). This statement is limited to the scope of standalone unfair methods of competition Section 5 violations. Such standalone unfair methods of competition Section 5 claims may be brought under one or more of the theories set forth in this policy statement and combined with claims under other parts of the FTC Act or other statutes enforced by the Commission as warranted.

This statement does not address the language of 15 U.S.C. § 45(b), which states that the Commission will act when it has reason to believe such action is in the public interest. *See generally Hills Bros. v. Fed. Trade Comm'n*, 9 F.2d 481, 483–84 (9th Cir. 1926) ("the interest of the public, like the question whether the commission has reason to believe that any person, partnership, or corporation has been or is using any unfair method of competition in commerce, is committed to the discretion of the commission, is to be determined by the commission before proceedings are instituted, and is not thereafter a subject of controversy either before the commission or before the court, except in so far as the question of public interest is necessarily involved in the merits of the case, and, if the commission finds that the method of competition in question is prohibited by the act, no other or further finding on the question of public interest is required."); *see also Parke, Austin & Lipscomb, Inc., et al. v. Fed. Trade Comm'n*, 142 F.2d 437, 441 (2d Cir. 1944).

[5] Statement of Commission, *supra* note 2.

[6] *Standard Oil Co. of New Jersey v. United States*, 221 U.S. 1, 60 (1911).

[7] S. REP. NO. 62-1326, at 10 (1913) ("Cummins Report"). Senator Francis Newlands, one of the chief sponsors of the bill that became the FTC Act, expressed concern that *Standard Oil* left antitrust regulation "to the varying judgments of different courts." 47 CONG. REC. 1225 (1911). After analyzing a series of Supreme Court decisions

Congress therefore determined it would "establish[ ] a commission for the better administration of the law and to aid in its enforcement."[8] This led to the creation of the FTC in 1914 and to the enactment of a prohibition of "unfair methods of competition," a new standard in federal competition law.[9]

In enacting Section 5, Congress's aim was to create a new prohibition broader than, and different from, the Sherman and Clayton Acts. Congress purposely introduced the phrase, "unfair methods of competition," in the FTC Act to distinguish the FTC's authority from the definition of "unfair competition" at common law.[10] It also made clear that Section 5 was designed to extend beyond the reach of the antitrust laws.[11] Concluding that a static definition would soon become outdated,[12] Congress wanted to give the Commission flexibility to adapt to changing circumstances.[13]

The key function of the FTC in applying its mandate to combat unfair methods of competition, according to Congress, would be to identify *unfair* forms of competition.[14] The legislative record demonstrates that Congress enacted Section 5 to protect against various types of unfair or oppressive conduct in the marketplace.[15] During debates over the meaning of unfair

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interpreting the Sherman Act, a Senate committee feared that the rule of reason resulted in a situation where, "in each instance it [would be] for the court to determine whether the established restraint of trade is a due restraint or an undue restraint." Cummins Report, at 10. It lamented that the rule of reason had made it "impossible to predict with any certainty" whether courts would condemn the many "practices that seriously interfere with competition" and found it inconceivable that "the courts . . . be permitted to test each restraint of trade by the economic standard which the individual members of the court may happen to approve." *Id*. at 10, 12. The committee believed this would result in a loss of confidence by the public in the courts and eventually lead to a "repudiat[ion] [of] the fundamental principles of representative government." *Id*. at 11.

[8] *Id*. at 12.

[9] Federal Trade Commission Act of 1914, Pub. L. No. 63-203, 38 Stat. 717 (codified as amended at 15 U.S.C. § 41–58). *See* 51 CONG. REC. 12146 (1914) (statement of Sen. Hollis) ("The Sherman Act is adequate for the abolition of monopoly; it is, however, but imperfectly adequate for the regulation of competition. The present Congress is charged with the duty of supplying the defect in the law").

[10] *See* 51 CONG. REC. 12936 (1914) (statement of Sen. Reed) ("It is my opinion that if we employ the term "unfair competition" as it is employed in this bill, without adding anything to it, the courts will adopt as the meaning of Congress that meaning which has been affixed to the term by all of the law dictionaries and by a great many legal authorities."). *See also* 51 CONG. REC. 12814 (1914) (statement of Sen. George Sutherland).

[11] *See E.I. du Pont de Nemours v. Fed. Trade Comm'n* (*Ethyl)*, 729 F.2d 128, 136 (2d Cir. 1984) ("Congress' aim was to protect society against oppressive anti-competitive conduct and thus assure that the conduct prohibited by the Sherman and Clayton Acts would be supplemented as necessary and any interstices filled") (citing H.R. REP. NO. 63-1142, at 19 (1914) (Conf. Rep.)); 51 CONG. REC. 11236 (1914) (statement of Sen. Cummins) (stating that the purpose of Section 5 was "to make some things punishable, to prevent some things, that cannot be punished or prevented under the antitrust law").

[12] H.R. REP. NO. 63-1142, at 19.

[13] *See id.* at 18–19.

[14] *Id*. at 19.

[15] *Id*. at 2 (declaring "unfair and oppressive competition to be unlawful"); S. REP. NO. 63-597, at 17 (1914) (citing a previous version of the bill, S. 2941, which would allow the commission to revoke the registration of any corporation using "materially unfair or oppressive methods of competition"); 51 CONG. REC. 8861 (1914) (statement of Rep. Hinebaugh) (seeking to prevent "unfair or oppressive competition" and proceeding to list examples); *id*. at 8979 (statement of Rep. Murdock) (seeking to protect to protect "smaller, weaker business organizations from the oppressive and unfair competition of their more powerful rivals"); *id*. at 13117 (statement of Sen. Reed) ("intended to reach unfair, dishonest, crooked, oppressive, coercive acts. It is not intended to cover mere mistakes").

methods of competition, members of Congress had no difficulty identifying concrete examples.[16] One congressman noted that when it comes to unfair methods of competition, "[t]here is that in the common sense of fairness and right dealing which indicates plainly the distinction between close bargaining and oppression."[17] Both the House and Senate also expressed a common understanding that unfair methods of competition encompassed conduct that tended to undermine "competitive conditions" in the marketplace.[18]

Congress evinced a clear aim that "unfair methods of competition" need not require a showing of current anticompetitive harm or anticompetitive intent in every case. First, the legislative history is replete with statements to the effect that Congress wanted the FTC to stop monopolies in their "incipiency."[19] Requiring the FTC to show current anticompetitive effects,

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[16] For instance, a Senate report referenced practices "such as local price cutting, interlocking directorates, and holding companies intended to restrain substantial competition." S. REP. NO. 63-597, at 13. In considering what conduct should be prohibited, the House distinguished between "artificial bases" of monopolistic power and "natural bases." *See* H.R. REP. NO. 63-533, at 23–25. The House viewed artificial bases of monopolistic power to include, for instance, the acceptance of rates or terms of service from common carriers not granted to other shippers; price discrimination not justified by differences in cost or distribution; procuring the secrets of competitors by bribery or any illegal means; procuring conduct on the part of employees of competitors inconsistent with their duties to their employers; making oppressive exclusive contracts; the maintenance of secret subsidiaries or secretly controlled agencies held out as independent; the destruction or material lessening of competition through the use of interlocking directorates; and the charging of exorbitant prices where the seller has a substantial monopoly. *Id*. Natural bases included control of natural resources, transportation facilities, financial resources, or any other economic condition inherent in the character of the industry, such as patent rights. *Id*. *See also* 51 CONG. REC. 11084–86 (1914) (statement of Sen. Newlands) (discussing jurisprudence on unfair competition); *id*. at 14928-14931 (statement of Rep. Covington) (discussing jurisprudence on unfair competition); *id*. at 11108 (statement of Sen. Newlands) (providing specific examples of unfair competition, such as local price cutting and organizing "bogus independent concerns . . . for the purpose of entering the field of the adversary and cutting prices with a view to his destruction[,]" among other things); *id*. at 11230 (statement of Sen. Robinson) (providing examples of unfair competition).

[17] 51 CONG. REC. 8979 (statement of Sen. Murdock).

[18] *See* S. REP. NO. 1326, at 3–4 (stating that "Congress should maintain the policy established by the anti-trust law" to "'maintain[ ] competitive conditions," and that "every possible effort to create and preserve competitive conditions should be made"); *id.* at 2, 3-4, 11, & 13; S. REP. NO. 63-597, at 10 ("a commission is a necessary adjunct to the preservation of competition and to the practical enforcement of the law"); H.R. Rep. No. 63-533, at 2 (1914) (reported by Rep. Covington) ("The administration idea and the idea of business men generally, is for the preservation of proper competitive conditions in our great interstate commerce."). The FTC Act's legislative history makes it clear that Congress intended the statute to protect a broad array of market participants including workers and rival businesses. *See* 51 CONG. REC. 13312 (1914) (statement of Sen. Reed) ("it is not required to show restraint of trade or monopoly, but that the acts complained of hinder the business of another, or prohibit another from engaging in business, or restrain trade"); *id*. (statement of Sen. White) ("one of the main objects of this legislation is to prevent a rival in business from using unfair competition to drive his competitor out of business and to prevent this before the business is destroyed"); 51 CONG. REC. 8979 (1914) (statement of Rep. Murdock) (purpose of new Commission "is to protect the smaller, weaker business organizations from the oppressive and unfair competition of their more powerful rivals"). The goals of "protecting consumers against the high prices and [guarding] the interests of employees" were expressed by the House. *See* H.R. REP. NO. 533, 63d Cong., 2d Sess. 14 (1914) (quoting from the Preliminary Report of the Industrial Commission, submitted to Congress in 1900). *See also* 51 CONG. REC. 8854 (1914) (statement of Rep. Morgan) (among goals of Section 5 "to secure labor the highest wage, the largest amount of employment under the most favorable conditions and circumstances").

[19] H.R. REP. NO. 63-1142, at 19 ("[t]he most certain way to stop monopoly at the threshold is to prevent unfair competition"); 51 CONG. REC. 13118) (1914) (statement of Sen. Reed) ("the same class of conspiracies exactly as the Sherman Antitrust Act deals with, except that we propose to strike those acts in their incipiency instead of after

which are typically seen only after the monopoly has passed the "embryonic" stage, would undercut Congress's hope to prohibit unfair business practices prior to, or near, monopoly power.[20] In addition, many of the practices listed by Congress as patently unfair do not automatically carry with them measurable effects.[21] Second, in considering and rejecting a definition of "unfair methods of competition" that would have required a showing of intent, legislators noted that such a requirement would inappropriately restrict the new provision to the metes and bounds of the antitrust laws and place an undue burden on the Commission in proving its cases.[22]

Congress struck an intentional balance when it enacted the FTC Act. It allowed the Commission to proceed against a broader range of anticompetitive conduct than can be reached under the Clayton and Sherman Acts, but it did not establish a private right of action under Section 5, and it limited the preclusive effects of the FTC's enforcement actions in private antitrust cases under the Sherman and Clayton Acts.[23]

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they have been actually worked out into a complete system of monopoly or restraint of trade"); *id*. at 14941 (statement of Rep. Stevens) (noting that section five "[would] give to this commission the power of preventing in their conception and in their beginning some of these unfair processes in competition which have been the chief source of monopoly"); *id*. at 12030 (statement of Sen. Newlands) (remarking that a commission would "check monopoly in the embryo"); *id*. at 11455 (statement of Sen. Cummins) (stating that the new law would "seize the offender before his ravages have gone to the length necessary in order to bring him within the law that we already have"); *id*. at 11087 (statement of Sen. Newlands) (citing the Cummins Report, which anticipated that a commission "could be vastly more effectual than through the courts alone, which in most cases will take no cognizance of violations of the law for months or years after the violation occurred, and when the difficulty of awarding reparation for the wrong is almost insurmountable").

[20] 51 CONG. REC. 13118 (statement of Sen. Reed) (declaring that Congress intended "to do something that will strike a death blow to monopoly. . . to arrest it in its infancy . . . [and] to strike those acts in their incipiency instead of after they have been actually worked out into a complete system of monopoly or restraint of trade."); *id*. at 14927 (statement of Rep. Covington) ("the best and most, effective way to deal with the various practices of unfair or destructive competition which, if permitted to go on unchecked and uncontrolled, become potential for restraint of trade or monopoly"); *id*. at 14929 (statement of Rep. Covington) ("We are seeking . . . to deal, with those practices of unfair trade in their incipient stages which if left untrammeled and uncontrolled become the acts which constitute in their culmination restraint of trade and monopoly and the groundwork of the trusts which have menaced us industrially").

[21] 51 CONG. REC. 12217 (statement of Sen. Newlands) ("all you would have to prove would be an unfair method whose tendency was to stifle competition."); 51 CONG. REC. 13312 (statement of Sen. White) (stating that "one of the main objects of this legislation is to prevent a rival in business from using unfair competition to drive his competitor out of business and to prevent this before the business is destroyed" and that "the unfair acts and practices had to have the effect to destroy or unreasonably hinder the business of another would neutralize this useful feature of the enactment"); 51 CONG. REC. 13311 (statement of Sen. Cummins) ("if the effect is to restrain trade or to create a monopoly[,] we have a complete and perfect prohibition in the antitrust law"); 51 CONG. REC. 13312 (1914) (statement of Sen. Reed) ("it is not required to show restraint of trade or monopoly, but that the acts complained of hinder the business of another, or prohibit another from engaging in business, or restrain trade"); 51 CONG. REC. 8979 (statement of Rep. Murdock) (purpose of new Commission "is to protect the smaller, weaker business organizations from the oppressive and unfair competition of their more powerful rivals.").

[22] 51 CONG. REC. 13311 (1914) (statement of Sen. Cummins) ("[t]here can be unfair competition in which the public is interested without any intent as described in the amendment"); *id*. ("[i]f the effect is to restrain trade or to create a monopoly we have a complete and perfect prohibition in the antitrust law"); *id*. at 13312 (statement of Sen. White) ("but we will have to carry the additional burden of proving the specific intent . . . [t]he proof of the specific intent with which an act was done is, as all lawyers know difficult to make").

[23] Treble damages are not available under the FTC Act. Civil penalties and Section 19's monetary remedies are limited to unfair and deceptive acts or practices. *See* 15 U.S.C. § 45(m)(1)(A); 15 U.S.C. § 57b. A finding that

The Supreme Court has affirmed this same broad view of the scope of Section 5 on numerous occasions.[24] It has condemned coercive and otherwise facially unfair practices that have a tendency to stifle or impair competition.[25] The federal circuit courts have likewise consistently held that the FTC's authority extends not only to "the letter," but also to "the spirit" of the antitrust laws.[26]

B. Congress created the FTC as an expert body charged with elucidating the meaning of Section 5

Congress was careful and deliberate when it created the FTC, an independent agency. The five Commissioners would serve for terms of seven years, which would "give them an opportunity to acquire the expertness" needed to determine what constitutes an unfair method of competition.[27] The Commission would provide guidance to the business community on the legality of business practices (including by issuing advisory opinions),[28] serve as an aid to the courts,[29] and act as an enforcer against unfair methods of competition.[30] Congress gave the Commission powers to conduct quasi-judicial hearings,[31] directly seek injunctive relief in federal court,[32] pursue investigations, prepare reports, and make rules.[33] To balance the Commission's powers, Congress created checks to ensure that the FTC would be accountable to it[34] and that the

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conduct is an unfair method of competition under Section 5 is not given collateral estoppel effect in subsequent private antitrust actions. *Holloway v. Bristol-Myers Corp*., 485 F.2d 986 (D.C. Cir. 1973) (holding that private litigants cannot sue for violations of the FTC Act). *See also* 51 CONG. REC. 13115 (1914) (statement of Sen. Newlands) ("I do not believe in the principle, of assessing threefold damages."); *id*. at 11317 (statement of Sen. McCumber) (moving to strike treble damages provision).

[24] *See supra*, note 3.

[25] *Texaco*, 393 U.S. at 225–26 (citing *Atlantic Refining Co.,* 381 U.S. at 376).

[26] *Ethyl*, 729 F.2d at 136–37 (citing *Sperry & Hutchinson*, 405 U.S. at 239); *Grand Union Co. v. Fed. Trade Comm'n,* 300 F.2d 92, 98–99 (2d Cir. 1962)). *Cf*., *Chuck's Feed & Seed Co. v. Ralston Purina Co*., 810 F.2d 1289, 1292–93 (4th Cir. 1987) (describing Section 5 "as a kind of penumbra around the federal antitrust statutes").

[27] S. REP. NO. 63-597 at 11. *See also id*. at 11 (anticipating that the Commission would "build up a comprehensive body of information for the use and advantage of the Government and the business world"); *id*. at 22 ("we want trained experts; we want precedents; we want a body of administrative law built up.").

[28] *See id*. at 6–7 (citing an address by President Wilson, stating that "the business men of the country . . . desire the advice, the definite guidance and information which can be supplied by an administrative body."); *id*. at 10 (anticipating that the Commission would "aid the business public.").

[29] *See* H.R. REP. NO. 63-533, at 8 (anticipating that the commission would use its investigatory powers in "aid of the courts.").

[30] S. REP. NO. 63-597, at 10 (anticipating that the Commission would have "sufficient power ancillary to the Department of Justice to aid materially and practically in the enforcement of the Sherman law and to aid the business public as well, and, incidentally, to build up a comprehensive body of information for the use and advantage of the Government and the business world"). *See also* H.R. REP. NO. 63-533, at 9.

[31] 15 U.S.C. § 45(b) (providing for adjudicatory hearings).

[32] 15 U.S.C. § 53(b).

[33] *Id*. § 46(a),(b) (authorizing the Commission to investigate corporations and require reports); *id*. § 46(g) (authorizing the Commission to "make rules and regulations for the purpose of carrying out the provisions of this subchapter"); *Nat'l Petroleum Refiners Ass'n v. Fed. Trade Comm'n*, 482 F.2d 672, 673 (D.C. Cir. 1973) (holding that "the Federal Trade Commission is authorized to promulgate rules defining the meaning of the statutory standards of the illegality the Commission is empowered to prevent").

[34] *See, e.g*., 15 U.S.C. § 46(d),(f),(h) (requiring reports to Congress); *Id*. § 57a(f)(7) (requiring annual reports to Congress); *Id*. § 57b-2(d)(1)(A) (providing for disclosure of protected information to Congress). Congress also holds

FTC's decisions would be reviewable by federal courts of appeal.[35] In the ensuing years, Congress has conducted vigorous oversight of the FTC and the courts have not hesitated to review Commission decisions.[36]

Congress intended for the FTC to be entitled to deference from the courts as an independent, expert agency.[37] Over the years, courts have consistently held that FTC determinations as to what practices constitute an unfair method of competition deserve "great weight,"[38] recognizing that the Commission is an expert agency, rather than "a carbon copy of the Department of Justice."[39]

Even when courts have rejected the Commission's factual conclusions, they have consistently reaffirmed the scope of its Section 5 authority.[40] For example, *Ethyl*, *Boise*, and *OAG* cited prior decisions of the Supreme Court that affirm the distinctive scope of Section 5,[41] but ultimately found that the particular facts at issue lacked evidence of unfairness, either "some indicia of oppressiveness"[42] or some evidence that the conduct tended to negatively affect the market.[43] All three appellate decisions reiterated the well-accepted principle that the Commission "is not confined to [the] letter" of the antitrust laws, and that "[i]t may bar incipient violations of

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the FTC accountable though the budgetary, appointment, and oversight processes, and through numerous statutory enactments and amendments relating to the FTC's powers over the course of the hundred-plus years since the passage of the Federal Trade Commission Act.

[35] 15 U.S.C. § 45(b). Respondents in adjudicative proceedings may receive judicial review of the Commission's decision in their circuit of residence or any circuit where they committed the conduct underlying the alleged violation: an unusually expansive form of judicial oversight. *See, e.g.,* J. Thomas Rosch Commissioner, Fed. Trade Comm'n, Three Questions About Part Three: Administrative Proceedings at the FTC, Remarks Before the American Bar Association Section of Antitrust Law Fall Forum, Washington, D.C. 18 (Nov. 8, 2012), https://www.ftc.gov/sites/default/files/documents/public_statements/three-questions-about-part-three-administrative-proceedings-ftc/121108fallforum.pdf.

[36] *See* William E. Kovacic, *The Federal Trade Commission and Congressional Oversight of Antitrust Enforcement*, 17 TULSA L.J. 587, 623–27 (1982). *See also Ethyl*, 729 F.2d at 137; *Boise Cascade Corp. v. Fed. Trade Comm'n*, 637 F.2d 573, 581–82 (9th Cir. 1980); *Official Airline Guides, Inc. v. Fed. Trade Comm'n (OAG)*, 630 F.2d 920, 927 (2d Cir. 1980).

[37] S. REP. NO. 63-597 at 11, 22.

[38] *OAG*, 630 F.2d at 927 (quoting *Cement Inst*itute, 333 U.S. at 720); *Atlantic Refining Co.*, 381 U.S. at 368; *Fed. Trade Comm'n v. R.F. Keppel & Bro., Inc.*, 291 U.S. 304, 314 (1934). *See also Ind. Fed'n of Dentists*, 476 U.S. at 455; *Texaco,* 393 U.S. at 226; *Motion Picture Advert. Serv. Co*., 344 U.S. at 396.

[39] *Fed. Trade Comm'n v. Dean Foods Co*., 384 U.S. 597, 618–19 (1966) (Fortas, J., dissenting). *See also* 51 CONG. REC. 12146 (statement of Sen. Henry Hollis) (observing that the DOJ would be able to focus on "the great task of prosecuting suits for the dissolution of monopolies, leaving to the trade commission the important service of policing competition, so as to protect small business men, keep an open field for new enterprise, and prevent the development of trusts").

[40] *See, e.g., Ethyl*, 729 F.2d at 128; *Boise*, 637 F.2d at 573; *OAG*, 630 F.2d at 920.

[41] *Boise,* 637 F.2d at 581; *Ethyl,* 729 F.2d at 136–37; *OAG,* 630 F.2d at 927.

[42] *Ethyl*, 729 F.2d at 139 (holding that "before business conduct in an oligopolistic industry may be labelled "unfair" within the meaning of § 5 a minimum standard demands that, absent a tacit agreement, at least some indicia of oppressiveness must exist"); *OAG,* 630 F.2d at 927–28 (finding that the monopolist had "no purpose to restrain competition or to enhance or expand his monopoly, and [did] not act coercively").

[43] *Boise*, 637 F.2d at 581 (finding that "without proof of anticompetitive effects" it could not assume that there was a "deliberate restraint on competition"). *Boise*'s applicability to cases outside the realm of delivered pricing is limited – the court's decision was driven by the Commission's inconsistent position on delivered pricing practices in prior statements, its shifting litigation strategy, and the Commission's failure to meets its own standard. *Id*. at 575–77, 582.

those statutes."[44] They also agreed that Section 5 reaches "conduct which, although not a violation of the letter of the antitrust laws, is close to a violation or is contrary to their spirit,"[45] and further recognized the importance of deference to the Commission where it acts against conduct that is unfair.[46]

III. Unfair Methods of Competition

Relying on the text, structure, legislative history of Section 5, precedent, and the FTC's experience applying the law, this statement describes the most significant general principles concerning whether conduct is an unfair method of competition under Section 5 of the FTC Act.[47]

1. The conduct must be a method of competition

Conduct must be a "method of competition" to violate Section 5. A method of competition is conduct undertaken by an actor in the marketplace—as opposed to merely a condition of the marketplace, not of the respondent's making, such as high concentration or barriers to entry.[48] The conduct must implicate competition, but the relationship can be indirect. For example, misuse of regulatory processes that can create or exploit impediments to competition (such as those related to licensing, patents, or standard setting) constitutes a method of competition.[49] Conversely, violations of generally applicable laws by themselves, such as environmental or tax laws, that merely give an actor a cost advantage would be unlikely to constitute a method of competition.

2. That is unfair

The method of competition must be unfair, meaning that the conduct goes beyond competition on the merits. Competition on the merits may include, for example, superior products or services, superior business acumen, truthful marketing and advertising practices,

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[44] *Ethyl,* 729 F.2d at 136. *See also Boise,* 637 F.2d at 581.
[45] *Ethyl,* 729 F.2d at 136–37.
[46] *Ind. Fed'n Dentists*, 476 U.S. at 454.
[47] Whether the conduct violates accepted norms of unfairness derived from external standards expressed in statutes, common law, and regulations outside of the federal antitrust laws may also be relevant to whether the conduct is an unfair method competition. *See Ind. Fed'n of Dentists*, 476 U.S. at 454 ("The standard of "unfairness" under the FTC Act …encompass[es] not only practices that violate the Sherman Act and the other antitrust laws. . . but also practices that the Commission determines are against public policy for other reasons."). *See also Sperry & Hutchinson*, 405 U.S. at 244; *Motion Picture Advertising Co.,* 344 U.S. at 395; *R.F. Keppel & Bro.*, 291 U.S. at 313. This framework will not be used to analyze matters that constitute a violation of the letter of the antitrust laws.
[48] *See Ethyl*, 729 F.2d at139.
[49] Statement of the Federal Trade Commission In the Matter of Google Inc., FTC File No. 121-0120 (Jan. 3, 2013), https://www.ftc.gov/system/files/documents/public_statements/410931/130103googlemotorolastmtofcomm.pdf; Statement of the Federal Trade Commission In the Matter of Robert Bosch GmbH, FTC. File No. 121-0081 (Apr. 24. 2013); Analysis of Proposed Consent Decree to Aid in Public Comment: In the Matter of Negotiated Data Solutions, LLC, FTC File No. 051-0094 (Jan. 23, 2008); *In re Dell Computer Corp*., 121 F.T.C. 616 (1996) (consent order). *Cf.*, *Walker Process Eqpt., Inc. v. Food Machinery Corp.*, 382 U.S. 172 (1965) (fraud on the patent office may constitute antitrust violation).

investment in research and development that leads to innovative outputs, or attracting employees and workers through the offering of better employment terms. [50]

There are two key criteria to consider when evaluating whether conduct goes beyond competition on the merits. First, the conduct may be coercive, exploitative, collusive, abusive, deceptive, predatory, or involve the use of economic power of a similar nature.[51] It may also be otherwise restrictive or exclusionary, depending on the circumstances, as discussed below. Second, the conduct must tend to negatively affect competitive conditions.[52] This may include, for example, conduct that tends to foreclose or impair the opportunities of market participants, reduce competition between rivals, limit choice, or otherwise harm consumers.

These two principles are weighed according to a sliding scale. Where the indicia of unfairness are clear, less may be necessary to show a tendency to negatively affect competitive conditions.[53] Even when conduct is not facially unfair, it may violate Section 5.[54] In these circumstances, more information about the nature of the commercial setting may be necessary to determine whether there is a tendency to negatively affect competitive conditions. The size, power, and purpose of the respondent may be relevant, as are the current and potential future effects of the conduct.

The second principle addresses the tendency of the conduct to negatively affect competitive conditions—whether by affecting consumers, workers, or other market participants. In crafting Section 5, Congress recognized that unfair methods of competition may take myriad forms and hence that different types of evidence can demonstrate a tendency to interfere with competitive conditions. Because the Section 5 analysis is purposely focused on incipient threats to competitive conditions,[55] this inquiry does not turn to whether the conduct directly caused

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[50] *See generally U.S. v. Grinnell Corp.*, 384 U.S. 563, 571 (1966) *(*distinguishing unlawful acquisition or maintenance of monopoly power from consequences of "a superior product, business acumen, or historic accident"); *U.S. v. Alum. Co. of America,* 148 F.2d 416, 430 (2d Cir. 1945) (distinguishing conduct based on "superior skill, foresight and industry.").

[51] *See e.g., Sperry & Hutchinson*, 405 U.S. at 905 (construing Section 5 to reach conduct shown to exploit consumers, citing *R.F. Keppel & Bro.*, 291 U.S. at 313); *Atlantic Refining Co.*, 381 U.S. at 369 (finding an unfair method of competition where the defendant "utilize[ed] … economic power in one market to curtail competition in another," which was "bolstered by actual threats and coercive practices")*; Texaco*, 393 U.S. at 228-29 (finding an unfair method of competition where the defendant used its "dominant economic power … in a manner which tended to foreclose competition")*; Ethyl, 729 F.2d* at 140 (finding that unfair methods of competition includes practices that are "collusive, coercive, predatory, restrictive, or deceitful" as well as "exclusionary").

[52] *See, e.g.,* S. REP. NO. 1326, at 3–4 (1913) (stating that "Congress should maintain the policy established by the anti-trust law" to "'maintain[ ] competitive conditions," and that "every possible effort to create and preserve competitive conditions should be made"). *Id.* at 2, 3-4, 11, & 13; *see also* H.R. Rep. No. 63-533, at 2 (1914) (reported by Rep. Covington) (The administration idea and the idea of business men generally, is for the preservation of proper competitive conditions in our great interstate commerce").

[53] *Ethyl*, 729 F.2d at 137-39.

[54] *Hastings Mfg. Co. v. Fed. Trade Comm'n*, 153 F.2d 253, 257 (6th Cir. 1946).

[55] *See generally supra* notes 11 & 18. *See also Fashion Originators' Guild Am. v. Fed. Trade Comm'n (FOGA)*, 312 U.S. 457, 466 (1941) (holding that it was not determinative that petitioners had not yet "achieved a complete monopoly"; rather it was "sufficient if it really tends to that end, and to deprive the public of the advantages which flow from free competition").

actual harm in the specific instance at issue.[56] Instead, the second part of the principle examines whether the respondent's conduct has a tendency to generate negative consequences; for instance, raising prices, reducing output, limiting choice, lowering quality, reducing innovation, impairing other market participants, or reducing the likelihood of potential or nascent competition. These consequences may arise when the conduct is examined in the aggregate along with the conduct of others engaging in the same or similar conduct,[57] or when the conduct is examined as part of the cumulative effect of a variety of different practices by the respondent.[58] Moreover, Section 5 does not require a separate showing of market power or market definition when the evidence indicates that such conduct tends to negatively affect competitive conditions.[59] Given the distinctive goals of Section 5, the inquiry will not focus on the "rule of reason" inquiries more common in cases under the Sherman Act, but will instead focus on stopping unfair methods of competition in their incipiency based on their tendency to harm competitive conditions.

IV. Potential Cognizable Justifications

In the event that conduct *prima facie* constitutes an unfair method of competition, liability normally ensues under Section 5 absent additional evidence. There is limited caselaw on what, if any, justifications may be cognizable in a standalone Section 5 unfair methods of competition case, and some courts have declined to consider justifications altogether.[60] In instances where a party chooses to assert justifications as an affirmative defense, the FTC can

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[56] *See Sperry & Hutchinson*, 405 U.S. at 244 (explaining that "unfair competitive practices [are] not limited to those likely to have anticompetitive consequences after the manner of the antitrust laws"); *Ethyl*, 729 F.2d at 138 (finding that evidence of actual harm can be "a relevant factor in determining whether the challenged conduct is unfair" but is not required); *Boise*, 637 F.2d at 581-82. *In re Coca-Cola Co.*, 117 F.T.C. 795, 915 (1994) (rejecting argument that Section 5 violation requires showing "anticompetitive effects"). *See also supra* notes 19-21 and accompanying text (explaining that a showing of an actual anticompetitive injury is unnecessary to prove a violation of Section 5 because that section was designed to stop in their incipiency acts and practices that could lead to violations of the Sherman and Clayton Acts).

[57] *Motion Picture Advertising*, 344 U.S. at 395.

[58] Consent Order, Statement in Support of Consent, *In the Matter of Intel Corp*., File No. 061-0247 (Dkt. 9341) (July 28, 2010); *The Vons Co.*, FTC Complaints and Order, 1987-1993 Transfer Binder, Trade Reg. Rep. (CCH) ¶ 23,200 (Aug. 7, 1992).

[59] *Atlantic Refining Co.,* 381 U.S. at 371 ("unnecessary to embark upon a full scale economic analysis of competitive effects."); *Texaco*, 393 U.S. at 230 (holding that "[i]t is enough that the Commission found that the practice in question unfairly burdened competition for a not insignificant volume of commerce."); *L.G. Balfour Co. v. Fed. Trade Comm'n*, 442 F.2d 1, 19-20 (7th Cir. 1971) (No proof of foreclosure necessary in an exclusive dealing contract case under Section 5 (citing *Brown Shoe*).

[60] *Atlantic Refining Co.*, 381 U.S. at 371 (considering the defendant's argument that the distribution contracts at issue "may well provide Atlantic with an economical method of assuring efficient product distribution among its dealers" and nonetheless holding that the "Commission was clearly justified in refusing the participants an opportunity to offset these evils by a showing of economic benefit to themselves"); *Texaco*, 393 U.S. at 230 (following the same reasoning as *Atlantic Refining* and finding that the "anticompetitive tendencies of such system [were] clear"); *Balfour*, 442 F.2d at 15 (while relevant to consider the advantages of a trade practice on individual companies in the market, this cannot excuse an otherwise illegal business practice). For provisions of the antitrust laws where courts have not accepted justifications as part of the legal analysis, the Commission will similarly not accept justifications when these claims are pursued through Section 5.

draw on the Commission's long experience evaluating asserted justifications when enforcing Section 5, as well as its review of decided cases and past enforcement actions.[61]

First, it would be contrary to the text, meaning, and case law of Section 5 to justify facially unfair conduct on the grounds that the conduct provides the respondent with some pecuniary benefits.[62] At the same time, some practices may impact competitive conditions in a manner that both harms and benefits market participants other than the party; at times, the harms and benefits may redound to the same participants, and at times they may be disparately distributed – that is, a practice may harm some market participants while simultaneously providing legitimate benefits to others.

If parties in these cases choose to assert a justification, the subsequent inquiry would not be a net efficiencies test or a numerical cost-benefit analysis. The unfair methods of competition framework explicitly contemplates a variety of non-quantifiable harms, and justifications and purported benefits may be unquantifiable as well. The nature of the harm is highly relevant to the inquiry; the more facially unfair and injurious the harm, the less likely it is to be overcome by a countervailing justification of any kind.[63] In addition, whether harmed parties share in the purported benefits of the practice may be relevant to the inquiry.

Some well-established limitations on what defenses are permissible in an antitrust case apply in the Section 5 context as well. It is the party's burden to show that the asserted justification for the conduct is legally cognizable,[64] non-pretextual,[65] and that any restriction used to bring about the benefit is narrowly tailored to limit any adverse impact on competitive

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[61] *See supra* § II (B) (discussing Congressional intent to create an expert Commission entitled to deference for its determinations).

[62] *Supra* note 51.

[63] *See FOGA*, 312 U.S. at 467-68 (finding the Commission did not need to hear evidence of justifications where "[t]he purpose and object of this combination, its potential power, its tendency to monopoly, the coercion it could and did practice upon a rival method of competition, all brought it within the policy of the prohibition declared by the Sherman and Clayton Acts").

[64] *See, e.g. Ind. Fed. Dentists*, 476 U.S. at 463 (making clear that justifications that run directly counter to the "basic policy of the Sherman Act," in this instance, limiting consumer access to relevant information because "an unrestrained market in which consumers are given access to the information they believe to be relevant to their choices will lead them to make unwise, and even dangerous, choices" are not cognizable); *id.* at 464 (affirming Commission's finding that there was insufficient evidence that the restraint conferred the claimed benefit at all). *See also Fed. Trade Comm'n v. Superior Ct. Trial Lawyers Ass'n*, 493 U.S. 411, 423-24 (1990); *NCAA v. Board of Regents*, 468 U.S. 85, 113-15 (1984); *United States v. Addyston Pipe Steel Co.* 85 F. 271 (6th Cir. 1898), *aff'd* 175 U.S. 211 (1899).

[65] Pretextual justifications include those that are not set forth in documents prior to, or contemporaneous with, the introduction of the conduct, or not plausibly based on the known facts. *See, e.g. Ind. Fed'n of Dentists*, 476 U.S. at 464 (affirming the Commission's finding that there was insufficient evidence that the restraint conferred the claimed benefit at all). *See also United States v. Microsoft Corp.*, 253 F.3d 35, 62-64, 72, 74, 76-77 (D.C. Cir. 2001); *Eastman Kodak Co. v. Image Technical Tech. Svcs*, 504 U.S. 541, 472, 484-85 (1992); *Aspen Skiing Co. v. Aspen Highlands Skiing Corp.*, 472 U.S. 585, 608-10 (1985); *Texas Specialty Physicians v. Fed. Trade Comm'n*, 528 F.3d 346, 368-70 (5th Cir. 2008); *United States v. Dentsply Int'l, Inc.*, 399 F.3d 181, 196-97 (3d Cir. 2005). *See also* Fed. Trade Comm'n & U.S. Dep't of Justice, Antitrust Guidelines for Collaboration Among Competitors §3.36a (2000) (2000 Collaboration Guidelines) ("Efficiency claims are not considered if they are vague or speculative or otherwise cannot be verified by reasonable means").

conditions.[66] In addition, the asserted benefits must not be outside the market where the harm occurs.[67] Finally, it is the party's burden to show that, given all the circumstances, the asserted benefits outweigh the harm and are of the kind that courts have recognized as cognizable in standalone Section 5 cases.[68]

V. Historical Examples of Unfair Methods of Competition

For the purpose of providing further guidance, the FTC lists here a non-exclusive set of examples and citations of past decisions and consent decrees based on Section 5, and, where applicable, other antitrust laws, focusing on conduct that constitutes an incipient violation of the antitrust laws or that violates the spirit of the antitrust laws. These illustrative examples are drawn from case law and from FTC experience.

A non-exclusive set of examples of conduct that have been found to violate Section 5 include:

- Practices deemed to violate Sections 1 and 2 of the Sherman Act or the provisions of the Clayton Act, as amended (the antitrust laws).[69]

- Conduct deemed to be an incipient violation of the antitrust laws. Incipient violations include conduct by respondents who have not gained full-fledged monopoly or market power, or by conduct that has the tendency to ripen into violations of the antitrust laws.[70] Past examples of such use of Section 5 of the FTC Act include:

    - invitations to collude,[71]

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[66] *NCAA v. Alston*, 141 S. Ct. 2141, 2162-64 (2021); *Polygram Holding, Inc. v. Fed. Trade Comm'n*, 416 F.3d 29, 38 (D.C. Cir. 2005); 2000 Collaboration Guidelines § 3.36b.

[67] *United States v. Philadelphia Nat'l Bank*, 374 U.S. 321, 370-71 (1963); 2000 Collaboration Guidelines § 3.36a.

[68] At all times, the burden of persuasion would remain with the Commission in administrative proceedings pursuant to 5 U.S.C. §556(d).

[69] *Motion Picture Advertising*, 344 U.S. at 395 (conduct fell "within the prohibitions of the Sherman Act and is therefore an unfair method of competition within the meaning of s. 5(a)."); *Cement Institute*, 333 U.S. at 683; *FOGA,* 312 U.S. at 463; *Fed. Trade Comm'n v. Pacific States Paper Trade Ass'n*, 273 U.S. 52 (1926).

[70] *FOGA*, 312 U.S. at 466 (FTC may challenge combinations "not merely in their fruition, but also in their incipiency combinations which could lead to . . .trade restraints and practices deemed undesirable"); *Motion Picture Advertising*, 344 U.S. at 394-95 ("[i]t is also clear that the Federal Trade Commission Act was designed to supplement and bolster the Sherman and the Clayton Act. . . to stop in their incipiency acts and practices which, when full blown, would violate those Acts."); *Cement Institute*, 333 U.S. at 708; *Triangle Conduit & Cable Co. v. Fed. Trade Comm'n*, 168 F.2d 175, 181 (7th Cir. 1948).

[71] The Commission has challenged both public and private invitations to collude as unfair methods of competition. This type of conduct, if consummated would constitute a per se violation of the antitrust laws. Invitations to collude, even if unaccepted, represent both an incipient violation as well as a violation of the spirit of the antitrust laws within the meaning of the 2022 Section 5 policy statement. Under either theory, an invitation to collude constitutes an unfair method of competition under Section 5. *In Re Quality Trailer Products Corp.,* 115 F.T.C. 944 (1992) (consent); *In re Valassis Communs*., Dkt. C-4160, 2006 FTC LEXIS 25 (2006) (consent); *In re A.E. Clevite*, 116 F.T.C. 389 (1993) (consent); *In re YKK (USA)*, 108 F.T.C. 628 (1993) (consent); *In re Precision Moulding Co.*, 122 F.T.C. 104 (1996) (consent); *In re Stone Container Corp.*, 125 F.T.C. 853 (1998) (consent); *In re U-Haul Int'l, Inc.*, File No. 081-0157, 6 (2010) (consent); *In re Delta/AirTran Baggage Fee Antitrust Litig.*, 245 F.Supp. 2d 1343,

- mergers, acquisitions, or joint ventures that have the tendency to ripen into violations of the antitrust laws,[72]

- a series of mergers, acquisitions, or joint ventures that tend to bring about the harms that the antitrust laws were designed to prevent, but individually may not have violated the antitrust laws,[73] and

- loyalty rebates, tying, bundling, and exclusive dealing arrangements that have the tendency to ripen into violations of the antitrust laws by virtue of industry conditions and the respondent's position within the industry.[74]

- Conduct that violates the spirit of the antitrust laws. This includes conduct that tends to cause potential harm similar to an antitrust violation, but that may or may not be covered by the literal language of the antitrust laws or that may or may not fall into a "gap" in those laws.[75] As such, the analysis may depart from prior precedent based on the provisions of the Sherman and Clayton Acts. Examples of such violations, to the extent not covered by the antitrust laws, include:

  - practices that facilitate tacit coordination,[76]

  - parallel exclusionary conduct that may cause aggregate harm,[77]

1369-70 (N.D. Ga. 2017), *aff'd sub. Nom.*, *Siegel v. Delta Air Lines, Inc.*, 714 F. App'x 986 (11th Cir. 2018), *cert. denied*, 139 S. Ct. 827 (2019). Depending on the circumstances, an invitation to collude may also constitute attempted monopolization under Section 2 of the Sherman Act, *United States v. American Airlines*, 743 F.2d 1114 (5th Cir. 1984), or wire fraud, *United States v. Ames Sintering*, 927 F.2d 232 (6th Cir. 1990).
Under appropriate circumstances, the Commission will refer evidence of per se illegal cartel agreements to the Department of Justice for criminal prosecution. *See* Commission Statement Regarding Criminal Referral and Partnership Process, File No. P094207 (Nov. 18, 2021), https://www.ftc.gov/system/files/documents/public_statements/1598439/commission_statement_regarding_criminal_referrals_and_partnership_process_updated_p094207.pdf.

[72] *Yamaha Motor Co. v. Fed. Trade Comm'n*, 657 F.2d 971 (8th Cir. 1981), *cert. denied*, 456 U.S. 915 (1982).

[73] *Vons*, 1987-1993 Transfer Binder ¶ 23,200. Such series of acquisitions or related conduct may also constitute an unfair method competition as a violation of the spirit of the antitrust laws. *See infra* note 82 and cases cited therein.

[74] *Luria Bros. v. Fed. Trade Comm'n*, 389 F.2d 847, 864 (3d Cir. 1968), *cert. denied*, 393 U.S. 829 (1968).

[75] Remarks of Jon Leibowitz, Comm'r, Fed. Trade Comm'n, "Tales from the Crypt" Episodes '08 and '09: The Return of Section 5 ("Unfair Methods of Competition in Commerce are Hereby Declared Unlawful"), Section 5 Workshop, at 4 (Oct. 17, 2008), https://www.ftc.gov/sites/default/files/documents/public_events/section-5-ftc-act-competition-statute/jleibowitz.pdf ("Simply put, consumers can still suffer plenty of harm for reasons not encompassed by the Sherman Act as it is currently enforced in the federal courts.").

[76] *Cement Institute*, 333 U.S. at 709-21 (multiple basing point pricing system contributed to unlawful coordinated pricing); Analysis to Aid Public Comment, *In re BMG Music et. al*, 65 Fed. Reg. 31,319 (2000), Docket No. C-3973 (2000) (Decision & Order) (distributors of pre-recorded music, acting in parallel but without agreement, impose identical coercive limits on retailer advertising of discounts). *See generally* William E. Kovacic, *Antitrust Policy and Horizontal Collusion in the 21st Century*, 9 LOY. CONSUMER L. REV. 97, 107 (1997) ("[T]he FTC remains perhaps the best vehicle for articulating standards designed to discourage anticompetitive coordination among competitors.").

[77] *Leegin Creative Leather Prods., Inc. v. PSKS, Inc.*, 551 U.S. 877, 897 (2007) (holding that the extent of adoption of resale price maintenance across the industry is relevant to legality); *Motion Picture Advertising*, 344 U.S. at 395

- conduct by a respondent that is undertaken with other acts and practices that cumulatively may tend to undermine competitive conditions in the market,[78]
- fraudulent and inequitable practices that undermine the standard-setting process or that interfere with the Patent Office's full examination of patent applications,[79]
- price discrimination claims such as knowingly inducing and receiving disproportionate promotional allowances against buyers not covered by Clayton Act,[80]
- de facto tying, bundling, exclusive dealing, or loyalty rebates that use market power in one market to entrench that power or impede competition in the same or a related market,[81]
- a series of mergers or acquisitions that tend to bring about the harms that the antitrust laws were designed to prevent, but individually may not have violated the antitrust laws,[82]
- mergers or acquisitions of a potential or nascent competitor that may tend to lessen current or future competition,[83]

("respondent and the three other major companies have foreclosed to competitors 75 percent of all available outlets."); *Standard Oil Co. of California v. United States*, 337 U.S. 293, 309, 314 (1949) (taking into account extent of industry use of similar practices). *See also* C. Scott Hemphill & Tim Wu, *Parallel Exclusion*, 122 YALE L.J. 1182, 1243-45 (2012) ("parallel exclusion is a suitable subject for FTC enforcement under Section 5 of the FTC Act.").

[78] Intel Consent Order at 9341; *Vons*, 1987-1993 Transfer Binder ¶ 23,200.

[79] U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, ANTITRUST GUIDELINES FOR THE LICENSING OF INTELLECTUAL PROPERTY § 6 (2017); *In re American Cyanamid Co.*, 72 F.T.C. 623, 684-85, *aff'd sub nom*, *Charles Pfizer & Co.*, 401 F.2d 574 (6th Cir. 1968), *cert. denied*, 394 U.S. 920 (1969) (actual or attempted enforcement of patents obtained by inequitable conduct falling short of fraud).

[80] *Alterman Foods v. Fed. Trade Comm'n*, 497 F.2d 993 (5th Cir. 1974); *Colonial Stores v. Fed. Trade Comm'n*, 450 F.2d 733 (5th Cir. 1971); R.H. *Macy & Co. v. Fed. Trade Comm'n*, 326 F.2d 445 (2d Cir. 1964); *American News Co. v. Fed. Trade Comm'n*, 300 F.2d 104 (2d Cir. 1962); *Grand Union Co. v. Fed. Trade Comm'n*, 300 F.2d 92 (2d Cir. 1962); *In re Foremost-McKesson, Inc.*, 109 F.T.C. 127 (1987).

[81] *Atlantic Refining Co.*, 381 U.S. at 357; *Texaco, Inc.*, 393 U.S. at 223; *Shell Oil Co. v. Fed. Trade Comm'n,* 360 F.2d 470 (5th Cir. 1966); *Brown Shoe*, 384 U.S. at 316.

[82] *The Vons Cos.,* 1987-1993 Transfer Binder ¶ 23,200. Section 5 has also been used to challenge individual transactions that do not meet the technical requirements of Section 7. *In re Beatrice Foods*, 67 F.T.C. 473 (1965), supplemented, 68 F.T.C. 1003 (1965), modified, 71 F.T.C. 797 (1967); *In re Dean Foods, Co.*, 70 F.T.C. 1146 (1966); *In re Foremost Dairies, Inc.*, 60 F.T.C. 944 (1962).

[83] *See, e.g., Fed. Trade Comm'n v. Facebook*, 581 F.Supp. 3d 34 (D.D.C. 2022) (denying motion to dismiss challenging acquisition of WhatsApp and Instagram); Analysis of Agreement Containing Consent Orders to Aid Public Comment, In the Matter of Novartis AG, File No. 141-0141 (consent decree requiring divestiture in transaction eliminating future competition in oncology compounds); Analysis of Agreement Containing Consent Orders to Aid Public Comment, *In the Matter of Össur Americas Holdings, Inc.*, File No. 191-0177 (consent decree requiring divestiture in transaction eliminating future competition in myoelectric elbows). *See also Fed. Trade Comm'n v. Procter & Gamble Co.*, 386 U.S. 568 (1967) (barring acquisition of leading firm where acquirer was most likely potential entrant). *See generally* PHILIP AREEDA & HERBERT HOVENKAMP, ANTITRUST LAW: AN ANALYSIS OF ANTITRUST PRINCIPLES AND THEIR APPLICATION ¶ 701at p. 200 (4th ed. 2015) (acquisition of "an

- using market power in one market to gain a competitive advantage in an adjacent market by, for example, utilizing technological incompatibilities to negatively impact competition in adjacent markets,[84]

- conduct resulting in direct evidence of harm, or likely harm to competition, that does not rely upon market definition,[85]

- interlocking directors and officers of competing firms not covered by the literal language of the Clayton Act,[86]

- commercial bribery and corporate espionage that tends to create or maintain market power,[87]

- false or deceptive advertising or marketing which tends to create or maintain market power,[88] or

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actual or likely potential competitor is properly classified, for it tends to augment or reinforce the monopoly by means other than competition on the merits."); C. Scott Hemphill & Tim Wu, *Nascent Competitors*, 168 U. PA. L. REV. 1879 (2020).

[84] *Eastman Kodak*, 504 U.S. at 451; *Newcal Industries v. Ikon Office Solution*, 513 F.3d 1038 (9th Cir. 2008); *SmithKline Corp. v. Eli Lilly & Co.*, 575 F.2d 1056 (3d Cir. 1978); *LePage's v. 3M Co.*, 324 F.3d 141 (3d Cir. 2003) (en banc).

[85] *Ind. Fed'n of Dentists*, 476 U.S. at 460-61 (finding of sustained effects legally sufficient even in absence of elaborate market analysis); *Toy's "R" Us v. Fed. Trade Comm'n*, 221 F.3d 928, 937 (7th Cir. 2000) (finding "sufficient proof of anticompetitive effects [such] that no more elaborate market analysis was necessary"). *Cf.*, *Fed. Trade Comm'n v. Staples, Inc.*, 970 F.Supp. 1066, 1075-6 (D.D.C. 1997) (relying in part on direct evidence that pricing for key products from office superstores lower where three such stores exist in same metropolitan area and higher where only one or two such stores present).

[86] *Perpetual Federal Savings & Loan*, 90 F.T.C. 608 (1977) (complaint dismissed due to subsequent legislation). *Cf.*, *TRW, Inc. v. FTC,* 647 F.2d 942 (9th Cir. 1981) (noting automatic nature of liability under Clayton §8 when prerequisites of statute established).

[87] *See* Policy Statement of the Federal Trade Commission on Rebates and Fees in Exchange for Excluding Lower-Cost Drug Products (2022), at 6 n. 27 ("The Commission has a long history of addressing commercial bribery and will continue to do so."), https://www.ftc.gov/legal-library/browse/policy-statement-federal-trade-commission-rebates-fees-exchange-excluding-lower-cost-drug-products; See Hon. Garland S. Ferguson, Jr., Chairman, Fed. Trade Comm'n, Commercial Bribery: An Address to the Conf. on Com. Bribery to the Comm. Standards Council and the Better Bus. Bureau of N.Y. (Oct. 17, 1930) (explaining the Commission's focus on commercial bribery as an unfair method of competition even before it gained authority under the Robinson-Patman Act); *see also* Donald S. Clark, Sec'y, Fed. Trade Comm'n, Remarks Regarding The Robinson-Patman Act: Annual Update, Before the Robinson Patman Act Comm., Section of Antitrust Law, 46th Annual Spring Meeting (Apr. 2, 1998), *See e.g.*, *In re Lockheed Corp.*, 92 F.T.C. 968 (1978) (commercial bribery).

[88] *In re Coleco Industries*, 111 F.T.C. 651 (1989) *(*consent decree barring claims of product availability unless actually available or company has reasonable basis for such claim*); In re Xerox Corp.*, 86 F.T.C. 364 (1975) (repeated publicizing release date of new products with knowledge that products would not be available by that date); Analysis of Proposed Consent Order to Aid Public Comment: *In the Matter of Intel Corp.*, Dkt No. 9341 at 5-6 (describing acts of deception in Commission complaint). *Cf, Microsoft*, 253 F.3d at 76-77 (acts of deception relating to compatibility of Microsoft version of Java with competing software applications as unlawful monopoly maintenance under the Sherman Act). *See generally* Maurice E. Stucke, *When a Monopolist Deceives*, 76 ANTITRUST L.J. 823 (2010). *See also* DANIEL A. CRANE, THE INSTITUTIONAL STRUCTURE OF ANTITRUST ENFORCEMENT 138 (2011) (The Commission is on strongest ground when challenging market power created by fraud or deception).

- discriminatory refusals to deal which tend to create or maintain market power.[89]

VI. The Path Forward

The FTC is committed to faithfully discharging its statutory obligations, including through enforcing and administering the prohibition against "unfair methods of competition" on a standalone basis, as laid out in Section 5 of the FTC Act, or in conjunction with its other statutory authorities.

[89] *Aspen*, 472 U.S. at 610-11 (affirming antitrust liability for termination of joint venture where no legitimate business justification present for such conduct); *Eastman Kodak*, 504 U.S. at 483-85 (denying summary judgment where defendant manufacturer of copiers refused to deal with third party service providers); *In re Grand Caillou Packing Co*., 65 F.T.C. 799 (1964), *aff'd in part and rev'd in part sub nom*., *LaPeyre v. Fed. Trade Comm'n*, 366 F.2d 117 (5th Cir. 1966) (violation of Section 5 for monopoly manufacturer of shrimp peeling machines to lease machines at substantially different rates in different regions of the US); Analysis of Proposed Consent Order to Aid Public Comment: In the Matter of Intel Corp., Dkt No. 9341 at 4 (describing alleged threatens of refusal to deal with customers who purchased non-Intel CPUs). *See generally* Brett Frischmann & Spencer Weber Waller, *Revitalizing Essential Facilities*, 75 ANTITRUST L.J. 1 (2008).

EXHIBIT 16

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EXHIBIT 17

Elendner, Hermann; Trimborn, Simon; Ong, Bobby; Lee, Teik Ming

Working Paper

The cross-section of crypto-currencies as financial assets: An overview

SFB 649 Discussion Paper, No. 2016-038

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SFB 649 Discussion Paper 2016-038

The Cross-Section of Crypto-Currencies as Financial Assets: An Overview

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The Cross-Section of Crypto-Currencies as Financial Assets: An Overview *

Hermann Elendner † Simon Trimborn ‡ Bobby Ong §
Teik Ming Lee ¶

October 3, 2016

Crypto-currencies have developed a vibrant market since bitcoin, the first crypto-currency, was created in 2009. We look at the properties of crypto-currencies as financial assets in a broad cross-section. We discuss approaches of altcoins to generate value and their trading and information platforms. Then we investigate crypto-currencies as alternative investment assets, studying their returns and the co-movements of altcoin prices with bitcoin and against each other. We evaluate their addition to investors' portfolios and document they are indeed able to enhance the diversification of portfolios due to their little co-movements with established assets, as well as with each other. Furthermore, we evaluate pure portfolios of crypto-currencies: an equally-weighted one, a value-weighted one, and one based on the CRypto-currency IndeX (CRIX). The CRIX portfolio displays lower risk than any individual of the liquid crypto-currencies. We also document the changing characteristics of the crypto-currency market. Deepening liquidity is accompanied by a rise in market value, and a growing number of altcoins is contributing larger amounts to aggregate crypto-currency market capitalization.

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Contents

1. Introduction

With Bitcoin, Satoshi Nakomoto permanently changed the world's investment universe to include purely virtual assets: in 2008 he invented the first digital currency. Less than a decade later, not only the original Bitcoin technology has evolved from a technical proof-of-concept to a serious and dependable investment asset: the underlying blockchain technology has spread and gained recognition, and a breath of several hundred of different crypto-currencies have been created and are actively traded. Virtual assets are no longer *one* alternative investment: cryptographic claims nowadays form an entire asset class for alternative investments, with a large cross-section to choose from.

The wide and fast proliferation of the blockchain technology owes to the open-source nature of Bitcoin, with its source-code publicly available at `github.com` and a free-software license that allows derivative works. Computer programmers worldwide can copy, modify and experiment upon the Bitcoin concept, thereby creating many alternative crypto-currencies (altcoins). This has brought about a vibrant ecosystem that allows for diverse experimentation in the development of digital currencies.

Crypto-currency traders worldwide have seized upon the altcoin growth to invest in an alternative asset free from government intervention, or to speculate on the often volatile values of these crypto-currencies. Some altcoins have led to significant improvements to the development of digital currencies as a whole, such as Ethereum, Ripple, Dash (formerly Darkcoin), Namecoin and others. For example, Ethereum is a crypto-platform that introduces a Turing-complete scripting language allowing for the creation of smart contracts; Dash allows for anonymity of blockchain transactions; Namecoin implements a decentralized Domain Name System.

Many altcoins, however, have been created as a simple clone of Bitcoin with minimal changes (see `dillingers.com/blog/2015/04/18` for a how-to): some due to a belief of different parameters being preferable; some with little other purpose than to pump-and-dump the market for a quick return.

There exist altcoin developers who have conducted outright scams via Initial Coin Offerings, with the creators disappearing after crowdsourcing bitcoins from the community. An example of an Initial Coin Offering (ICO) scam is Edgecoin, where the organisers changed their original ICO annoucement to one informing that they had been hacked, see `bitcointalk.org`. Meanwhile, some altcoins have also been created with illigitimate aims such as stealing users' personal details or bitcoin private keys through the installation of malware and trojans onto altcoin wallets.

The presence of free-riders and fraudsters, however, does not imply a fundamental weakness of the asset class; it stems from the sudden growth in the early stages of a new market and from the presence of many unknowledgable participants (Böhme et al., 2015). After all, in the early days when the first joint-stock corporations publicly floated their shares, stock scams were widespread, and physical currencies are plagued by counterfeiting to this day. Yet who would exclude stocks and currencies from investment considerations?

These nuisances should not distract from the fact that crypto-currencies are a new asset class that is here to stay. The cryptographic claims are based on a strong, highly

competitive and remarkably resilient technology: the blockchain. As the economy is becoming more and more digital, the role of digital assets in investment decisions will also grow. To exclude digital assets from investment choices, in particular in light of their properties this chapter will point out, will become as restrictive as excluding entire other asset classes.

This chapter serves as an introduction to crypto-currencies as alternative investments: We consider their properties as financial assets, with a particular focus on their returns, as well as their diversification effect in investment portfolios. We investigate the movements of the crypto-currencies, analyze the co-movements of the altcoins and Bitcoin and compare their relation to established assets like stock indices, real estate, gold and US Treasury Bills.

2. The dynamic environment of a multiplicity of crypto-currencies

While Bitcoin still is the most valuable crypto-currency, the investment universe of blockchain-based crypto-currencies has seen higher than proportional growth for alternative implementations, so-called *altcoins*.

As at time of writing (31 August 2016), `coinmarketcap.com` lists 767 active altcoins. This list is not exhaustive: many more have been and are being created; only the most liquid ones are traded on altcoin exchanges and listed on Coinmarketcap. The others are deemed too illiquid. However, the existence of many insignificant crypto-currencies must not detract from the fact that the importance of altcoins as alternative investment vehicles is growing: Altcoin market capitalization as a percentage of total market capitalization of crypto-currencies including Bitcoin has already reached 19%.

One major factor enabling such growth has been the relative ease of setting up new crypto-currencies.

2.1. Starting yet another crypto-currency

In 2014, altcoins were rapidly being created each day, with the number of altcoins listed on Coinmarketcap increasing from 69 in January 2014 to 590 by December 2014, see `web.archive.org`. Growth in active altcoins has since tapered off and the number of active altcoins has been hovering between 650 to 770 since June 2015.

There are two types of altcoins listed on Coinmarketcap, namely crypto-currencies and crypto-assets. Crypto-currencies have their own blockchain and require their own timestamping mechanism. Examples of crypto-currencies are Litecoin, Peercoin, Ether, Dogecoin, Stellar etc.

Crypto-assets do not have their own blockchain or timestamping mechanism but instead are created off crypto-currency platforms and rely on the main crypto-currency's blockchain. Examples of crypto-currency platforms (which also serve as a crypto-currency) are Counterparty, NXT, Ethereum, Omni (previously Mastercoin), and Bitshares. Some

examples of crypto-assets that are based off these crypto-currency platforms are MaidSafeCoin (a crypto-asset of Omni), DigixDAO (a crypto-asset of Ethereum), Storjcoin X (a crypto-asset of Counterparty), SuperNET (a crypto-asset of NXT) and others.

It requires technical knowledge to create or even to clone an existing crypto-currency. Creating a crypto-asset on the other hand is relatively simple and does not require strong technical expertise.

2.2. A brief history of altcoins and approaches to generate value

The first altcoin ever created was the Bitcoin Testnet 1, created by Gavin Andresen (see `reddit.com`); it has by now been abandoned. One of the earliest crypto-currencies still in active use is Ripple, an exceptional altcoin with respect to its development, which to a large degree is independent of Bitcoin's. Not only do these two crypto-currencies employ different timestamping models, with Ripple using the Consensus protocol, see Schwartz et al. (2014), against Bitcoin's SHA-256 Proof-of-Work: Ripple is also implemented with an entirely different source code – a rarity, since most crypto-currencies are built as edited versions of Bitcoin's source code.

Namecoin was one of the earliest designs of innovative altcoins, in the sense that it was created with the aim of functionality beyond coin transfers, i.e., for a different use-case: Namecoin was built to improve decentralization by serving as an alternative decentralized Domain Name System (DNS) system and identity storage. DNS servers, the machines which store the look-up information to link internet domain names to those computers effectively serving the associated content, are until today controlled by governments and large corporations – an infrastructure setup that allows for certain websites to be censored. Namecoin enables the creation of `.bit` websites which cannot be censored. Furthermore, Namecoin also allows for the storage of key/value data, which proves useful for identity management. For instance, the startup Onename used to store information on individual identities on the Namecoin blockchain (but has since moved to the Bitcoin blockchain due to security reasons, `blog.onename.com`). Namecoin is also noteworthy for being the first fork of Bitcoin and the first altcoin to implement merged mining with Bitcoin on the SHA-256 Proof-of-Work algorithm, see `namecoin.info`.

The first major altcoin to make use of a different hashing algorithm was Tenebrix, which used the Scrypt Proof-of-Work algorithm. However, likely due to an excessive pre-mine of 7.7 million coins out of a cap of 10.5 million, Tenebrix did not survive. Pre-mining refers to mining before the general public is invited to participate in the operation of the blockchain, and hence before anybody but the developers can participate in the seignorage, obtaiing newly created coins. Naturally, large pre-mines are perceived very critically by potential altcoin investors, as it effectively allocates a significant fraction of the aggregate (also long-run) money supply to the developers before the coin's launch.

In the early days of altcoin creations, however, debates about altcoin designs centered mostly on the concrete parametrisation of the blockchain. Parameters such as total coins available for mining, transaction time and distribution period were pivotal in arguments about pros and cons of an altcoin. Hence, many altcoins were purely a re-incarnation of the Bitcoin blockchain with a different set of parameter choices. A classical example

of such parameter tweaking to "improve" Bitcoin is Litecoin. Table 1 compares the parameters of Bitcoin and Litecoin.

	Bitcoin	**Litecoin**
Coin Limit	21 million	84 million
Timestamping	proof of work	proof of work
Proof-of-Work Hashing Algorithm	SHA-256	Scrypt
Block Time	10 minutes	2.5 minutes
Difficulty Retarget	2,106 blocks	2,106 blocks
Block Reward Halving	every 210,000 blocks	every 840,000 blocks
Initial Block Reward	50 BTC	50 LTC
Created By	Satoshi Nakomoto	Charlie Lee
Creation Date	3 January 2009	7 October 2011

Table 1: Comparison of parameters of Bitcoin and Litecoin. Source: `coindesk.com`

Following the trend of tweaking parameters for altcoins, developers started innovating on the *proof-of-work* concept. In order to prevent adversaries from undermining the network, the blockchain requires every new block to contain proof that a certain (expected) amount of effort has been invested. This proof of work is rewarded with newly created coins (seignorage) and transaction fees (if any). The proof is delivered in the form of a number that solves a computational problem which is hard to solve but very easy to verify. In this context, "hard to solve" means that the only way to come up with a solution is a trial-and-error approach that requires sizable computational resources ("number crunching;" the difficulty of the problem is re-set periodically so that on average a new block is found after a given block time).

This proof-of-work approach makes the propagation of a fraudulent continuation of the blockchain prohibitively expensive ("51% attack"), but it does imply that sizable amounts of computational power (and hence electricity) are used to ensure the blockchain's operation. While the frequently voiced position that this energy be "wasted" certainly overlooks the fact that other payment systems also require far from negligible expenses to operate and maintain, even if they do not achieve independence from a trusted third party, it led to the development of an alternative approach to ensure the blockchain cannot be extended illegitimately: *proof of stake.*

The proof-of-stake idea was first mooted by the Bitcointalk user QuantumMechanic in July 2011, see `bitcointalk.org`. Sunny King, the founder of Peercoin (previously known as PPCoin) was the first to implement a proof-of-stake altcoin, see King and Nadal (2012). The aim the proof-of-stake design was to remove the need to expend computational resources in securing the blockchain. The right to extend the blockchain is not obtained by providing the solution to a computational riddle, but rather requires a party to prove ownership of a certain amount of coins. In order to attack a proof-of-stake altcoin, an attacker would not need to surpass the entire remaining community in terms of computational power, but rather buy a significant portion of the coins outstanding. In this case, however, attacking the coin (and thus destroying its value) will no longer be incentive

compatible; at least unless the threat to do it anyway is credible (Houy, 2014). For more information, see the article of Vitalik Buterin, the founder of Ethereum, explaining the differences between Proof-of-Work and Proof-of-Stake, in `bitcoinmagazine.com`.

The debate about the relative mertis of proof of work vs. proof of stake is still active, however, and development of proof-of-work altcoins has kept progressing. For instance, tweaking Bitcoin's SHA-256 algorithm allowed more individual miners to participate in the network in order to keep it decentralized. As a result of these innovations, we see many altcoins launching with algorithms such as Scrypt, X11, X13, X15, Blake-256, Groestl and more. Developers also started launching altcoins using multiple hashing algorithms, such as Myriadcoin which uses 5 hashing algorithms: SHA256d, Scrypt, Myr-Groestl, Skein, and Qubit.

The third approach to ensure the integrity of a blockchain is *proof of burn,* first used by Counterparty. The counterparty tokens, XCP, were distributed proportionately to everyone who destroyed bitcoins by sending them to an unrecoverable address during the proof-of-burn period in January 2014, `counterparty.io`. The proof of burn was used by the team launching Counterparty to ensure the legitimate distribution of coins. This process helped the Counterparty team establish credibility as the developers do not gain anything from the bitcoins "burnt."

Another trend that started in 2014 was altcoin developers launching sovereign altcoins, associated with particular countries. The first such sovereign altcoin was Auroracoin, created in February 2014 to serve as the crypto-currency for the nation of Iceland. Like most of these sovereign altcoins, Auroracoin distributed the coins to residents via an airdrop: Icelandic residents entered their resident ID on Auroracoin's official website, and received their reserved 50% of the total supply of Auroracoin, see `coindesk.com`.

A sizable hype ensued, making Auroracoin the second-largest crypto-currency in terms of market capitalization in March 2014, see `blogs.wsj.com`. The success of Auroracoin inspired other developers to launch similar sovereign altcoins for other nations or territories such as Pesetacoin (Spain), Scotcoin (Scotland), eGulden (Netherlands), Mazacoin (Lakota Nation – a Native American territory in USA) and others. For a list, see `coindesk.com`.

Next, development efforts were directed at altcoins with anonymity as a design goal. The pseudonymous nature of Bitcoin was sufficient to attract transfers for illegitimate or illegal purposes, but the public and unalterable trace of all transactions also provided the basis for successes by law enforcement in identifying the agents behind certain transactions. Altcoins such as Dash (previously known as Darkcoin), Monero, ShadowCash and others aimed at providing the possibility of transferring coins without disclosing one's identity. Dash, for example, has a PrivateSend (previously known as DarkSend) implementation that extends the idea of CoinJoin, first proposed by Bitcoin core developer Gregory Maxwell as a way to improve bitcoin transaction anonymity by combining bitcoin transactions with another person's transactions, see `bitcointalk.org`. Duffield and Diaz (2015) in their Dash whitepaper point out three methods in which bitcoin transactions can be de-anonymized: through linking and forward linking via identified exchanges, and also CoinJoin amount tracing. PrivateSend requires at least 3 participants and for it to work, each participant needs to submit transaction inputs and outputs in common

denominations of 0.1DASH, 1DASH, 10DASH and 100DASH.

Potentially the most important developments, however, were those to add *smart-contract* capabilities onto the blockchain. Some platforms that are built on top of the Bitcoin blockchain to add this functionality include Omni (previously Mastercoin), Counterparty and Rootstock. Other developers have created new platforms such as Ethereum, Bitshares and NXT. Platforms such as Ethereum introduced new concepts into the protocol such as a Turing-complete programming language, allowing to create arbitrarily complex smart contracts.

These platforms allow for the creation of crypto-assets and supported the growth of crypto-assets. For example, Counterparty has a total of 50,520 assets (according to `blockscan.com`), NXT has 685 assets (`nxtreporting.com`), and Bitshares has 198 active assets (`cryptofresh.com`), at the time of writing. Despite the high number of crypto-assets, most of these are not actively traded. CoinMarketCap lists only 59 actively traded crypto-assets, see `coinmarketcap.com`. The most successful crypto-asset is the DAO: it raised USD 162 million worth of tokens; however, on 17 June 2016, a vulnerability in the code resulted in the loss of 3.6 million ethers worth USD 60 million, see `coindesk.com`. The resolution of this problem by re-defining the blockchain led to a fork and heated debate.

Finally, the growth of enthusiasm about Bitcoin has been reflected in the growth of bitcoin transactions, to the point that today developers are discussing how to ensure the protocol can accommodate such high growth rates well into the future. To this end, the blockchain itself will likely need to be decentralised, and work is progressing on so-called *pegged sidechains* (Back et al., 2014). To get onto a sidechain, a user will send bitcoins to a specially-formed Bitcoin address. Bitcoins sent to the address are immobilized (not within anyone's control). Once the transaction is confirmed, tokens on the sidechain are released that can be controlled by the same user. The reverse can happen once the tokens in the sidechain are no longer needed. Sidechains are essentially altcoins in a Bitcoin ecosystem. There are numerous interesting applications that can take place once this proposal goes live and may well be the future direction of crypto-currencies.

2.3. Altcoin trading platforms

Both the desire to innovate and the ease of building on the Bitcoin implementation have thus led to the breadth of various altcoins available for investment and as media of exchange. They are traded online with huge discrepancies in liquidity.

Trading activity of popular altcoins is conducted at online crypto-currency exchanges. Similarly to exchanges trading BTC for sovereign currencies, these exchanges commonly operate continuously, i.e., 24 hours per day, 7 days every week. The complete alignment of trading hours with calendar time provides an aspect of liquidity that the world's largest stock exchanges do not provide.

Altcoin exchanges operate one order book per currency pair, where prices are determined from active trading. Most altcoins are thereby traded against bitcoins, effectively making it the virtual reserve currency. Only the most popular altcoins sometimes have trading pairs with fiat currencies such as the US Dollar, the Euro, the Chinese Yuan, or the

Russian Ruble.

One of the largest altcoin exchanges by trading volume at the time of writing is `poloniex.com`. Poloniex is a US-based exchange that does not support fiat-currency trading. Poloniex supports trading of 115 altcoins across 135 market pairs with 4 base currencies of bitcoin (BTC), ether (ETH), monero (XMR) and tether (USDT). Poloniex's 24-hour trading volume on 24 July 2016 was 67,906 BTC.

Most trading volume occurs on the BTC base currency. There are 108 markets with bitcoin, 15 markets with monero, 8 markets with tether and 4 markets with ether as base currency. The most popular market pair on Poloniex is ETH/BTC with 24-hour trading volume of over 41,000 BTC. This is followed by ETC/BTC, NXT/BTC, LSK/BTC, DAO/BTC and STEEM/BTC.

One of the oldest altcoin exchanges is `btc-e.com`. Btc-e has been in operation since July 2011. Its owner and location, however, is uncertain, with its terms of use claiming that it is bound by the laws of Cyprus, website description claiming it is operating from Bulgaria, and the website having a strong Russian language design. Despite its shady circumstances, btc-e has been in operation for a long time and has withstood many competitors who have since ceased to exist.

Currently, btc-e supports trading of 7 altcoins across 18 market pairs with 5 base currencies of US Dollar, Euro, Russian Ruble, bitcoin (BTC) and litecoin (LTC). Btc-e's 24-hour trading volume on 24 July 2016 was 4,721 BTC; a small number compared to Poloniex.

Yobit, Bittrex, C-Cex are exchanges which offer support for many altcoins. Yobit supports 618 altcoins, Bittrex supports 205 altcoins and C-Cex supports 143 altcoins, and these three exchanges offer traders more opportunities in trading their altcoins when the altcoins are not listed on Poloniex.

It is quite common for altcoin exchanges to disappear overnight in this industry with the most popular narrative being that the exchange has been hacked. Without proper security precautions in place, hackers can run away with funds in an exchange making it insolvent. Users are advised to not store any altcoins on the exchanges to reduce counterparty risk. Some of the popular altcoin exchanges that have disappeared with users' funds over the years are Cryptsy, Mintpal and Vircurex.

2.4. Altcoin information platforms

There are many sources of information that can be used to analyse the crypto-currency ecosystem. One of the primary sources of information is to use blockchain data. `blockchain.info` provides online Bitcoin wallets and also data such as price, mined blocks, number of transactions and various others statistics.

Alternative block explorers providing blockchain information for Bitcoin are `kaiko.com` and `blockr.io`. Since each crypto-currency has its own blockchain, the information for each altcoin needs to be obtained from each individual altcoin's block explorer. `BitInfocharts.com` provides statistics for selected altcoins.

While block-explorer services are suitable for the average user to obtain information related to the blockchain, application developers prefer more flexibility in interacting with

the blockchain and may opt for Application Program Interface (API) services such as `BlockCypher.com` and `BitGo.com`. Traditionally, developers need to host a bitcoin node in order to obtain the latest transactions and blocks. With these services, the barriers to entry for developers to build apps on top of the bitcoin blockchain are reduced.

To get more information on the level of decentralization in Bitcoin, one can use Bitnodes (available at `bitnodes.21.co`). Bitnodes attempt to estimate the size of the Bitcoin network by finding reachable Bitcoin nodes in the network.

To get information on the latest price for bitcoin, it needs to be obtained from the dozens of exchanges operating worldwide. Each of these exchanges have their own market and orderbook and due to the differences in transaction volume, each bitcoin exchange will quote different bid/ask prices. So far, there has not been a global standard in determining the bitcoin "spot price." There are several initiatives to identify the true spot price of bitcoin such as the CoinDesk Bitcoin Price Index and the Winkdex.

In September 2013, the Coindesk Bitcoin Price Index (BPI) was launched by CoinDesk. The aim of BPI is to establish the standard retail price reference for industry participants and accounting professionals. Due to the growing importance of the bitcoin market in China, a specialized BPI for the Chinese Yuan market was introduced in March 2014. At the time of writing, the following exchanges are included in the USD index: Bitstamp, Bitfinex, GDAX, itBit and OKCoin while the following exchanges are included in the CNY index: BTC China, Huobi and OKCoin. The minimum criteria for a Bitcoin exchange to be included in the BPI are the following, see `coindesk.com/price` and `coindesk.com` for reference:

1. USD exchanges must serve an international customer base.
2. The exchange must provide bid-offer quotes for an immediate sale (offer) and an immediate purchase (bid).
3. Minimum trade size must be less than 1,500 USD (9,000 CNY) or equivalent.
4. Daily trading volume must meet minimum acceptable levels as determined by CoinDesk.
5. The exchange must represent at least 5% of the total 30-day cumulative volume for all of the exchanges included in the XBP.
6. The stated and/or actual time for a majority of fiat currency and bitcoin transfers (whether deposits or withdrawals) must not exceed two business days.

In July 2014, the Winkdex price index was launched by Cameron and Tyler Winklevoss. The Winkdex formula is calculated based on the top three highest-volume Bitcoin exchanges in the previous two-hour period using a volume-weighted exponential moving average. Transactions executed on exchanges with higher volumes and most recent by time would provide a higher weight to the Winkdex formula, see `winkdex.com`.

Finally there is `BitcoinWisdom.com`, a real-time bitcoin market chart website. BitcoinWisdom offers real-time price charts allowing users to apply technical analysis onto Bitcoin and selected altcoin markets. BitcoinWisdom gives a real-time overview on what is happening in major bitcoin exchanges by streaming data on order books and executed trades.

For altcoin pricing, volume and trading data, one will have to refer to other online services such as `CoinMarketCap.com`, `CoinGecko.com`, and `CoinHills.com`. CoinMarketCap is a website that tracks the market capitalization of all active crypto-currencies using the following formula: weighted average price multiplied by total available supply.

CoinGecko is a website that tracks crypto-currencies beyond market capitalization. The website ranks crypto-currencies based on several other metrics such as liquidity, developer activity, community and public interest, see `coingecko.com`. CoinGecko was based on the premise that a strong community and developer team form the foundation of a crypto-currency with good growth.

CoinHills is a website that tracks the price and trading activity of various crypto-currencies from different exchanges. CoinHills does not rank altcoins but provides insights on the the exchanges and altcoins with the most trading volume on a real-time basis. Using Coinhills, traders can learn more about unusual activities in the crypto-currency markets and obtain potential trading ideas.

To capture the evolution of the values of crypto-currencies in the cross-section, `crix.hu-berlin.de` offers an index which tracks the average price movement of the most representative altcoins, similar to a stock-market index. CRIX determines the coins included via an information criterion and weighs their return contributions by the respective amounts of coins at the start of each month. Thus, CRIX mimics a monthly rebalanced portfolio. While S&P500 and the CSI300 provide a summary statistic about the current state of the US and Chinese markets, respectively, CRIX does the same for the crypto-currency market. CRIX was proposed by Härdle and Trimborn (2015) and further investigated by Trimborn and Härdle (2016). The first publication proposes a first version of CRIX and compares the dynamics of the index against other markets. The latter further develops the methodology of CRIX and evaluates the performance of the methodology on other markets.

3. Properties of crypto-currency dynamics

While there is ongoing debate about whether altcoins should legitimately be characterised as *currencies* or rather as *digital assets* (Yermack, 2015), undisputably they represent an alternative investment with the evolution of their value of key importance. From the perspective of their owner, next to their usefulness as media of exchange, their capabilities as stores of value are critical; or put differently: the financial returns to holding the digital coins. The emergence of a broad cross-section of different coins has prompted the necessity to assess the risk and return profiles of hundreds of different assets, as well as considerations of diversification and portfolio management.

This section provides an overview of the returns to the price processes of crypto-currencies in general from the perspective of an altcoin investor. While it cannot claim completeness, it is aimed to characterise the cross-section broadly.

3.1. The universe of crypto-currencies

There currently exist 767 crypto-currencies while our dataset consists of 327. Some altcoins have effectively already gone extinct, while others permanently emerge in the market. This nascent market constantly exhibits substantial changes.

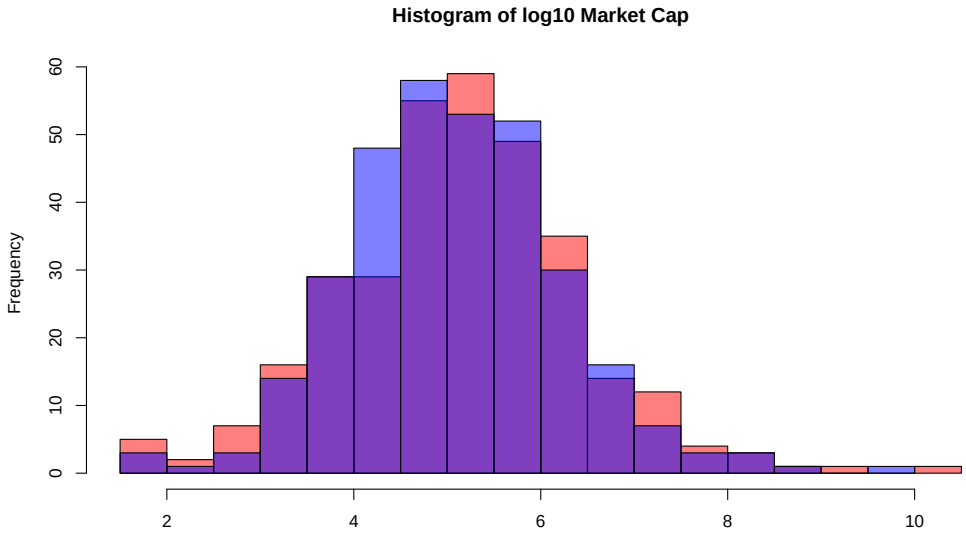

Figure 1: Frequency of market capitalization on a log scale on 2016-07-24 (shaded red) and in the time period 2015-07-25 until 2016-07-24 (shaded blue) for all crypto-currencies. The overlapping area is displayed in purple.

CCSHistMarketCap

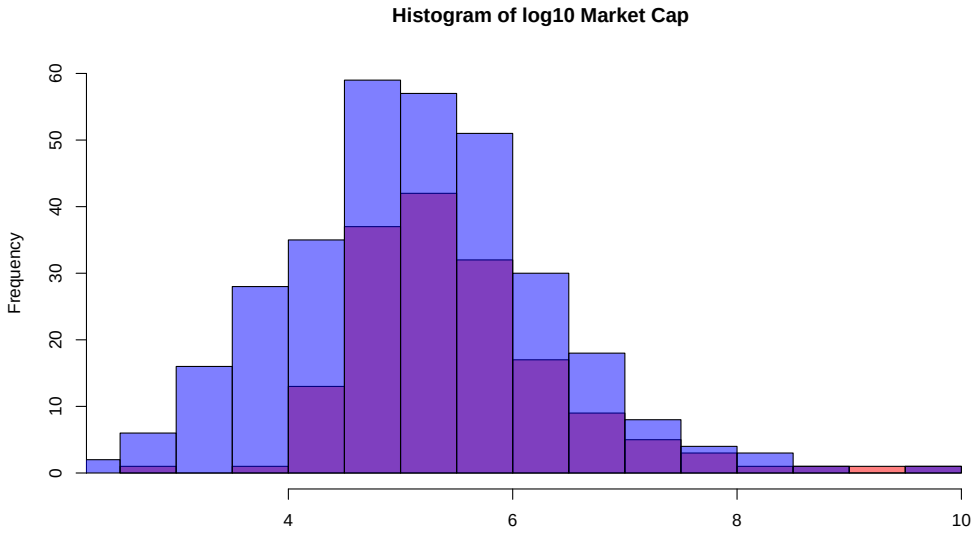

Figure 2: Frequencies cover the periods 2014-03-30 to 2014-08-01 (shaded red) and 2016-01-01 to 2016-07-24 (shaded blue). Overlapping areas in purple. Time intervals cover periods of high market capitalization, compare Figure 4.

CCSHistMarketCapHighValAreas

Figure 1 shows that in the last year most of the crypto-currencies exhibited aggregate market valuations in the range of 1,000 to 10,000,000 USD. Comparing distribution at the end of our sample with the mean over the last year, a shift of mass in the direction of the tails becomes visible. Mostly crypto-currencies with market capitalization between 10,000 and 32,000 USD either gained or lost in value or vanished from the market.

To analyze structural shifts in the market, a closer look over certain time horizons is called for. For instance, Figure 4 reveals that the aggregate crypto-currency market exhibited fairly high market capitalization in the beginning of the observed time period, declined subsequently, and achieved again similar values at the end of the time period.

Figure 2 shows the surprising result that in the earlier sub-period in 2014, more crypto-currencies with high market capitalization were present in the market, as compared to the later sub-period in 2016. In the latter period, the recovery of the aggregate market value was driven mainly by crypto-currencies with smaller valuations having become more frequent in the market.

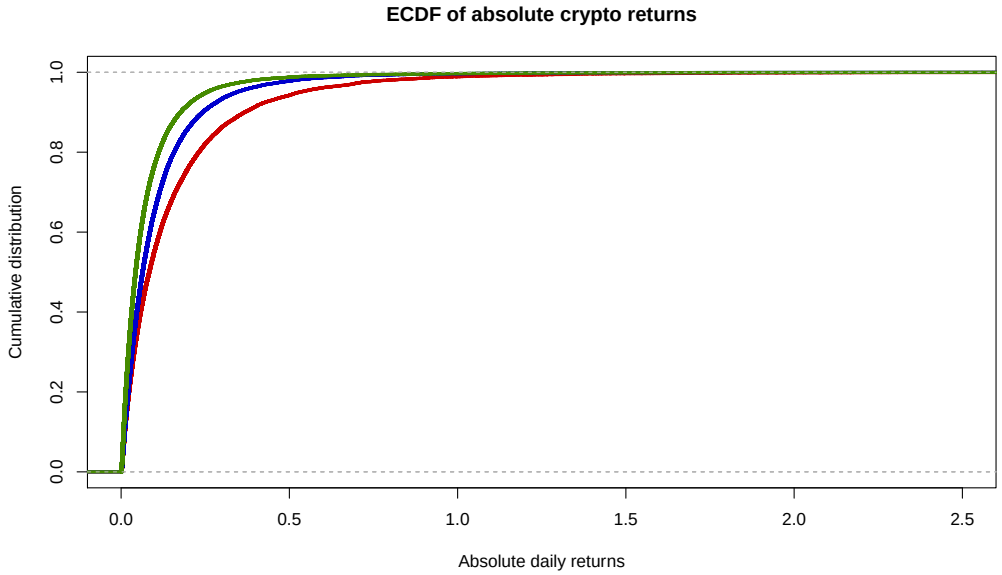

Figure 3: The figure shows the empirical cumulative distribution of the absolute returns of all crypto-currencies in the dataset, divided into three groups depending on their mean market value. Group1 has a mean market value below or equal 50,000, group2 between 50,000 and 500,000 and group3 above 500,000. Excluded were returns where the daily trading volume was below 10 USD.

CCSecdf

Assets with differences in certain features, like market value, often exhibit differences in the behavior of their returns. Stocks have an often-observed size effect, see e.g., Gabaix (2009). Figure 3 shows the empirical cumulative distribution function (ecdf) of the absolute returns of all crypto-currencies for different sizes of market value. Apparently, crypto-currencies with smaller mean market value exhibit higher returns; crypto-currencies

therefore share the size effect with stocks.

3.2. The evolution of the crypto-currency universe over time

As detailed, the relative ease of constructing a new crypto-currency and the diversity of objectives regarding their desired properties lead to a dynamic environment with new currencies being introduced and some established ones fading out of usage over often short intervals of time. At the same time, the distribution of trading volumes attracted by various currencies is highly skewed, with BTC generally still generating the dominating fraction of aggregate daily trading volume.

The entire market showed a high increase in daily trading volume over the observed time period 2014-03-30 to 2016-07-24. Figure 4 shows that the relatively thin trading volume in 2014 was accompanied by a frequent change in the market capitalizations. After a strong decline of capitalization in early 2015, market cap increased until the end of the observation period while showing deepening liquidity.

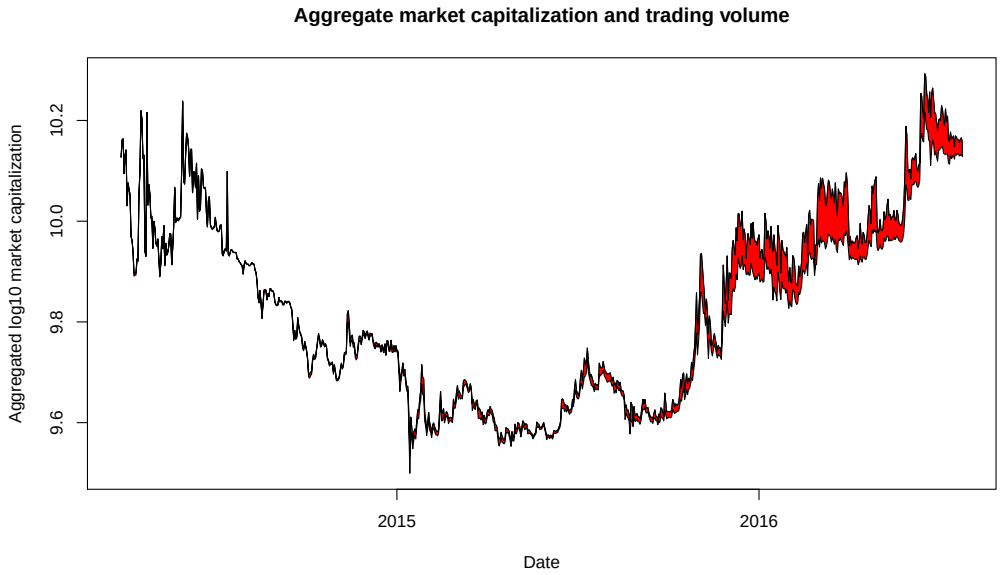

Figure 4: Evolution of aggregate market capitalization on $\log_{10}$ scale over the period 2014-03-30 to 2016-07-24. The width of the line (spanned in red) indicates the daily trading volume of the aggregate market.

CCSMarketCapvsVol

3.3. Liquidity of crypto-currencies

Figure 5 displays the evolution of daily trading volume for the 10 major crypto-currencies, using a logarithmic scale due to the high skewness of volumes across crypto-currencies.

More results on standard liquidity measures are reported by Fink and Johann (2014).

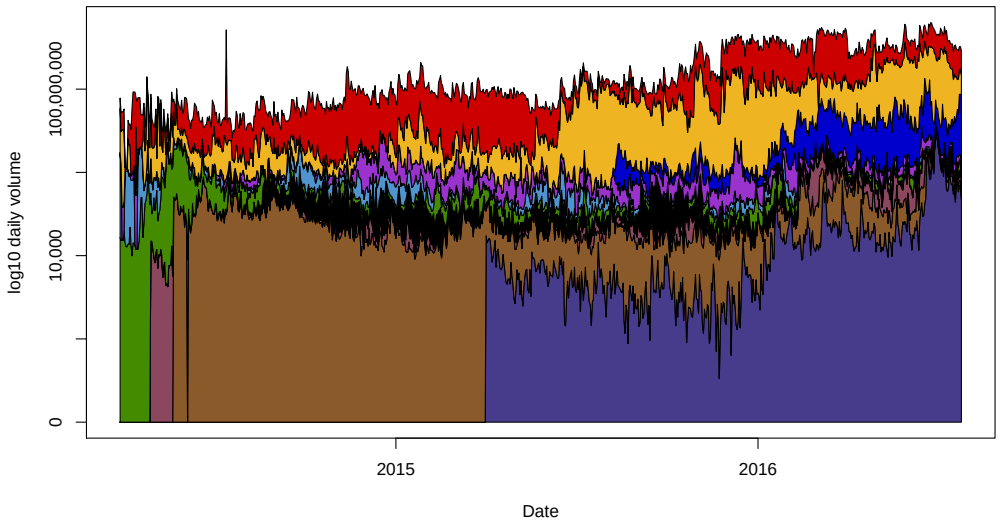

Figure 5: Daily USD trading volume of the ten major crypto-currencies over 2014-03-30 to 2016-07-24, on log scale. Color code is BTC, ETH, XRP, LTC, DASH, DOGE, MAID, BTS, XEM, XMR. Crypto-currencies entering the dataset display a spike. The volume per crypto-currency is depicted by the heigth of its colored area; hence the upper contour describes aggreate volume over all 10 crypto-currencies.
CCSCryptoSurvival

3.4. Financial returns on investing in crypto-currencies

3.4.1. Summary statistics

Compared to standard financial assets, crypto-currencies exhibit remarkably higher dispersion in their returns. Table 2 displays summary statistics for the currently most important (in terms of market capitalization) 10 crypto-currencies.

	BTC	ETH	XRP	LTC	DASH	MAID	DOGE	XEM	XMR	BTS
maximum	22.31	55.24	86.02	41.82	114.24	72.91	61.65	69.50	123.93	64.31
upper decile q_{90}	3.37	11.88	4.92	4.12	7.85	9.02	5.15	10.09	9.03	6.65
upper quartile q_{75}	1.32	4.95	1.73	1.29	2.76	4.07	1.74	3.88	3.42	2.40
median	0.09	−0.07	−0.22	−0.18	−0.20	−0.07	−0.39	−0.13	−0.09	−0.61
mean	0.09	1.07	0.10	−0.01	0.66	0.54	0.08	1.10	0.38	0.18
lower quartile q_{25}	−1.21	−3.39	−1.97	−1.60	−2.82	−3.55	−2.35	−3.41	−3.56	−3.34
lower decile q_{10}	−3.07	−7.29	−4.73	−4.41	−6.39	−7.66	−4.90	−8.00	−7.63	−6.58
minimum	−22.26	−48.33	−34.22	−42.14	−40.80	−31.20	−28.62	−24.87	−29.43	−23.74
percentage negative	47.85	50.57	53.24	52.98	52.73	51.19	56.90	51.98	50.51	55.71
volatility	3.34	9.28	6.03	5.34	9.07	8.44	6.10	10.04	8.77	7.70
N	848	351	848	848	848	817	848	479	794	733

Table 2: Descriptive statistics on simple daily returns (in percent) of the 10 crypto-currencies with the largest final market capitalizations over the time period 2014-03-30 to 2016-07-24.

	BTC	ETH	XRP	LTC	DASH	MAID	DOGE	XEM	XMR	BTS	CRIX	EW	VW
volatility	0.034	0.092	0.057	0.054	0.083	0.081	0.058	0.092	0.081	0.071	0.032	0.045	0.062
skewness	−0.564	−0.612	1.152	−0.805	1.268	0.500	1.062	1.334	1.164	1.774	−0.680	2.495	0.614
excess kurtosis	8.617	9.550	22.953	20.637	16.581	6.603	11.059	6.357	14.511	10.549	8.990	28.897	29.354
VaR at 1%	0.072	0.207	0.064	0.117	0.104	0.170	0.069	0.124	0.121	0.119	0.064	0.103	0.068
exp. shortfall at 1%	0.098	0.306	0.085	0.194	0.138	0.231	0.101	0.134	0.148	0.147	0.089	0.135	0.093
VaR at 5%	0.034	0.107	0.036	0.042	0.063	0.116	0.038	0.086	0.078	0.082	0.031	0.058	0.034
exp. shortfall at 5%	0.056	0.178	0.055	0.082	0.092	0.172	0.061	0.107	0.107	0.111	0.052	0.089	0.055
CAPM β	0.103	−0.519	0.436	−0.098	0.614	0.032	0.052	−0.501	0.374	0.605	0.009	−0.099	−0.270
N	838	350	819	840	842	717	840	479	792	727	724	724	723

Table 3: Risk measures, including value at risk, expected shortfall, and the CAPM β, for daily log returns of the 10 crypto-currencies with highest final market capitalizations and for three crypto-currency portfolios over the time period 2014-03-30 to 2016-07-24. The portfolios are investments into the crypto-currency index CRIX, into an equally-weighted portfolio (EW), or a value-weighted portfolio (VW) of all crypto-currencies in our dataset.

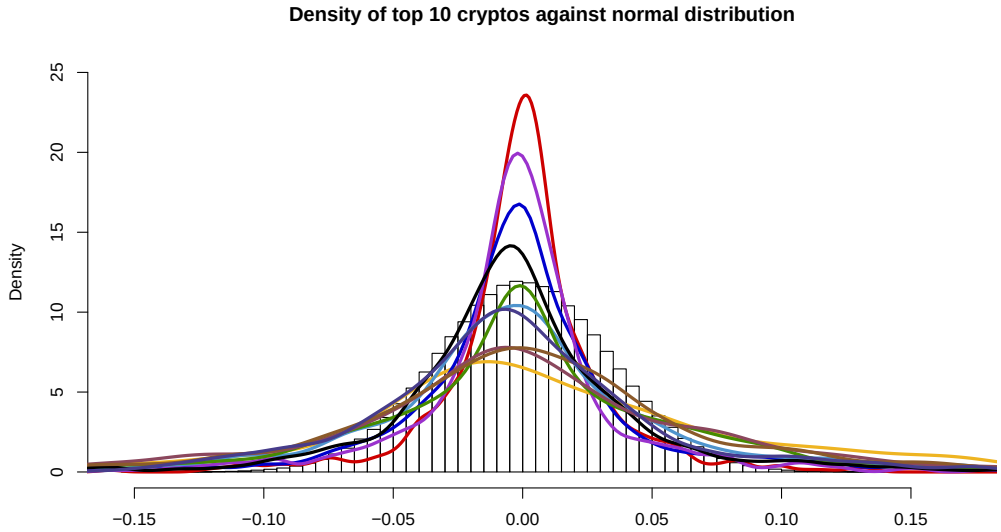

Figure 6: The probability density functions of the distributions of daily returns for the main 10 crypto-currencies with the following colour code: BTC, ETH, XRP, LTC, DASH, DOGE, MAID, BTS, XEM, XMR. A normal distribution with the same mean and standard deviation as the returns on BTC is displayed as a histogram in the background. The observation period is 2014-03-30 to 2016-07-24.

CCSHistReturnsDensity

The first interesting fact which these crypto-currencies share can be inferred from the mean and median. The means are – except for LTC – positive while the medians are mostly negative. Obviously most of the returns are negative but with a smaller absolute degree than the positive ones. The row 'percentage negative' shows the extent of this implication. Notice that BTC is the only crypto-currency with more positive returns than negative ones, a fact which strengthens its special role in the crypto-currency market.

Crypto-currencies thus lose value more frequently than they gain, but gain in stronger movements. The quantiles, maximal and minimal values support this result. Mostly the maximal simple return is higher than the minimal one, where LTC is the exception again. Also the upper deciles are mostly greater than or at least very close to the lower ones in absolute value. These two findings imply that the returns in the positive tail are sizably bigger than the ones in the negative tails, measured in absolute values.

Figure 6 shows the densities of the returns of the top 10 crypto-currencies by

market capitalization (and for comparison the normal distribution). Apparently the crypto-currencies with higher market cap have more weight around zero. All of the crypto-currencies show deviations from the Gaussian distribution. Especially the tails are heavier. This visual result is supported by the measures of skewness and kurtosis, see Table 3.

3.4.2. Returns and their stability over time

Having established that crypto-currencies, unlike most fiat currencies, exhibit sizable fluctuations in their market value even over short time horizons, the question arises how the risk inherent in an altcoin position and the related expected returns evolve over time. Figure 7 displays the evolution of the main parameters of the return distribution of the crypto-currencies over time, evaluated in rolling windows of 180 trading days. Since crypto-currencies are traded on all days including weekends, this corresponds to half a year. The upper panel shows the means; standard deviation serves as a risk measure and is depicted in the lower panel. The figure showcases the high instability of crypto-currencies' risk and return properties over time: Some, like BTC, even have a lower mean when the standard deviation is higher. Others, like LTC, exhibit the opposite pattern. Apparently, the higher standard deviations result from opposing reasons: for some crypto-currencies from higher positive and for others from higher negative returns. However, since idiosyncratic risk will not be priced, we need to turn to risk compensation in the following.

At this point the analysis has showed that even simple properties of the return process as means and standard deviations are unstable over time. In the following, we investigate the risk of investment in the crypto-currency market further.

3.4.3. Risk measures

The measures of value at risk (VaR) and expected shortfall (ES) are given in Table 3, both at a risk level of 1% and 5%. Definitions and calculation details are in Section A.1.

XRP bears the lowest risk in terms of the two risk measures, but must still be considered highly risky in comparison to standard financial assets. Its ES at the 1% level is 8.53%, which means that the expected loss over the days which are the worst with a 1 in 100 chance is 8.53%. ETH exhibits the highest value with 30.57% of daily expected loss at the same risk level. Clearly, these crypto-currencies are no stable investments but entail high risk. However, due to their low correlations especially with established assets (see Section 3.4.4)

they provide strong diversification benefits in a portfolio.

Next we investigate βs in the context of the CAPM, with the S&P500 as the market index. The βs, see Table 3, show very different sensitivities of crypto-currencies to the market excess rate. This measure implies that movements of the top 10 crypto-currencies are little correlated with the stock market.

In the following, we investigate the question of the co-movement of crypto-currencies deeper by means of correlations and PCA.

3.4.4. Diversification in a crypto-currency portfolio

In light of the similarity of many crypto-currencies and the fact that their implementations often share large parts of their source code (and arguably the investor base), it may be expected that the returns among the class of altcoins exhibit a high degree of co-movement. This intuition, however, is wrong. Table 4 shows that among the top 10 crypto-currencies, most pairs exhibit low return correlations. More importantly, Table 8 displays the results of a principal-component analysis of the altcoins' daily returns: the single-strongest factor only explains 26% of the variation of crypto-currency returns. Moreover, each subsequent factor is providing only slowly declining additional information content, so that 7 factors are needed in order to account for 90% of the variation from these 10 crypto-currencies, visualized in Figure 8.

This result already shows a distinct movement of the crypto-currencies. The rotation matrix – upper part of the Table 8 – shows that the returns are adequately displayed by different factors of the PCA. For explanation, consider the two most important crypto-currencies in terms of market value in the dataset, ETH and BTC. While ETH shows strong representation in the first factors, BTC is represented by the latter factors. This observation is supported by the low correlation of the two crypto-currencies, see Table 4.

However, the question arises whether the return co-movements are only this low unconditionally, and are subject to spikes for (strong) negative-return times as is common for stocks? We thus calcualte pairwise correlations separately for days on which CRIX moves up vs. down and report the results in Table 5. Clearly, correlations indeed are stronger on days of negative movements; however, most crypto-currency pairs still exhibit surprisingly low correlations after all. Results are qualitatively similar if we partion the days into positive and negative ones by following the S&P500 index instead of CRIX.

Focusing on correlations of volatilities, and restricting the days of positive/negative market movements to the tenth/first decile of the market's return distribution yields the results in Table 6. Here correlations are somewhat higher, and again differences between positive and negative conditions pertain. However,

	BTC	ETH	XRP	LTC	DASH	MAID	DOGE	XEM	XMR	BTS
BTC		0.08	0.17	0.58	0.33	0.24	0.43	0.32	0.31	0.27
ETH	0.13		0.03	0.05	0.10	0.29	0.05	−0.01	0.12	0.19
XRP	0.00	0.61		0.12	0.07	0.19	0.13	0.10	−0.02	0.16
LTC	0.00	0.33	0.00		0.20	0.08	0.43	0.23	0.21	0.20
DASH	0.00	0.06	0.03	0.00		0.11	0.17	0.11	0.15	0.11
MAID	0.00	0.00	0.00	0.02	0.00		0.12	0.02	0.14	0.14
DOGE	0.00	0.37	0.00	0.00	0.00	0.00		0.20	0.15	0.28
XEM	0.00	0.82	0.03	0.00	0.02	0.73	0.00		0.04	0.12
XMR	0.00	0.02	0.65	0.00	0.00	0.00	0.00	0.38		0.22
BTS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	

Table 4: The upper triangular displays the correlations of the crypto-currencies BTC, ETH, XRP, LTC, DASH, DOGE, MAID, BTS, XEM, XMR against each other. Missing values were pairwise omitted. The lower triangular shows the corresponding p-values.

	BTC	ETH	XRP	LTC	DASH	MAID	DOGE	XEM	XMR	BTS
BTC		0.02	0.07	0.31	0.25	0.11	0.30	0.25	0.25	0.11
ETH	−0.08		−0.03	0.03	0.05	0.22	0.02	−0.03	0.17	0.19
XRP	0.16	0.02		0.05	0.07	0.11	0.14	0.09	−0.01	0.16
LTC	0.69	−0.11	0.08		0.12	−0.05	0.23	0.15	0.08	0.13
DASH	0.36	0.09	0.08	0.32		0.05	0.17	0.08	0.17	0.05
MAID	0.28	0.35	0.12	0.13	0.20		0.08	−0.06	0.12	0.11
DOGE	0.40	−0.01	0.05	0.39	0.20	0.09		0.15	0.04	0.23
XEM	0.32	−0.07	0.03	0.27	0.04	0.11	0.16		−0.09	0.08
XMR	0.41	−0.01	0.10	0.29	0.15	0.18	0.18	0.14		0.16
BTS	0.30	0.17	0.10	0.16	0.07	0.10	0.25	0.14	0.22	

Table 5: Pairwise crypto-currency correlations of returns separately for positive (upper triangular matrix) and negative (lower triangular matrix) market-movement days, as defined by returns on CRIX.

correlations are still lower than in public stock markets.

It can be concluded that various crypto-currencies are not close substitutes. Rather, their different technical properties give rise both to different usability as media of exchange and stores of value as well as different price dynamics.

This fact also strengthens the rationale for capturing the aggregate crypto-market movement via an index like CRIX, proposed by Härdle and Trimborn (2015), further investigated by Trimborn and Härdle (2016) and available at `crix.hu-berlin.de`. Table 3 shows that an investment strategy based on CRIX also exhibits the lowest risk in terms of Value-at-Risk (VaR) and Expected Shortfall (ES), the risk measure currently proposed by the Basel Committee on Banking Supervision (BCBS, 2014). This holds despite the fact that equally-weighted (EW) and value-weighted (VW) portfolios are re-balanced daily for

	BTC	ETH	XRP	LTC	DASH	MAID	DOGE	XEM	XMR	BTS
BTC		0.15	0.22	0.65	0.32	0.14	0.56	0.47	0.34	0.23
ETH	−0.06		0.01	0.11	0.19	0.37	0.19	0.06	0.04	0.23
XRP	0.11	−0.04		0.16	0.18	0.17	0.21	0.17	0.03	0.26
LTC	0.52	−0.03	0.07		0.26	0.02	0.55	0.43	0.15	0.25
DASH	0.41	−0.01	0.04	0.21		0.12	0.21	0.19	0.04	0.18
MAID	0.27	0.26	0.21	0.09	0.13		0.14	0.04	0.11	0.10
DOGE	0.41	−0.06	0.06	0.45	0.24	0.11		0.38	0.16	0.43
XEM	0.26	−0.08	0.08	0.11	0.07	−0.02	0.12		0.12	0.22
XMR	0.29	0.16	−0.08	0.23	0.15	0.16	0.17	−0.03		0.15
BTS	0.28	0.18	0.07	0.19	0.13	0.25	0.23	0.01	0.30	

Table 6: Pairwise crypto-currency correlations of volatilities separately for days with returns in the highest decile (upper triangular matrix) and lowest decile (lower triangular matrix) of market movements, as defined by returns on the S&P500.

	BTC	ETH	XRP	LTC	DASH	MAID	DOGE	XEM	XMR	BTS
USD/EUR	−0.05	−0.04	0.04	−0.06	−0.01	−0.03	−0.06	−0.01	−0.05	−0.03
JPY/USD	0.02	−0.04	−0.03	−0.04	0.09	0.02	0.05	−0.05	0.02	0.06
USD/GBP	−0.06	−0.09	0.04	−0.09	−0.01	−0.01	−0.02	−0.17	−0.04	−0.03
Gold	0.05	0.04	0.04	0.05	−0.01	0.07	0.01	0.09	0.02	−0.01
SP500	0.00	−0.05	0.05	−0.05	0.02	0.00	0.01	−0.05	0.03	0.04
XWD	0.01	−0.03	0.02	−0.07	0.03	0.03	0.01	−0.07	0.05	0.07
EEM	0.00	−0.09	0.04	−0.09	0.00	−0.01	0.02	−0.04	0.02	0.04
REIT	0.03	−0.09	0.04	0.05	0.00	−0.03	0.01	0.05	−0.01	−0.05
DTB3	0.02	0.09	0.00	0.02	0.03	0.04	0.04	0.07	0.03	0.05
DGS10	−0.02	−0.08	0.00	−0.02	0.01	−0.03	−0.01	−0.01	−0.02	−0.01

Table 7: Correlations between BTC, ETH, XRP, LTC, DASH, DOGE, MAID, BTS, XEM, XMR and conventional financial assets: 3 exchange rates, gold, 3 stock indices, real estate and the US Treasury Bills Rates.

all crypto-currencies in the dataset (Section A.2), while CRIX is re-balanced monthly, with a quarterly selection of index constituents; and even though BTC has a high influence in CRIX (and naturally the VW portfolio) due to its high market value.

So far, we have addressed the potential for diversification of a portfolio consisting exclusively of crypto-currencies. Prior studies, in particular Eisl et al. (2015) and also Briere et al. (2013), have shown that, at least for BTC, including the digital asset in a standard financial portfolio provides a sizable effect on diversification as well. Table 7 shows the correlation of the top 10 crypto-currencies by market value and 10 standard financial assets. The correlations between these assets and the crypto-currencies are very close to zero, which is especially surprising for the fiat-currency returns on USD/EUR, USD/JPY,

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10
btc	−0.13	−0.04	0.11	−0.07	0.19	−0.23	0.03	0.05	0.46	0.81
eth	−0.44	0.70	−0.46	−0.32	0.07	−0.01	−0.04	0.02	−0.02	−0.01
xrp	−0.08	−0.01	0.08	0.02	−0.01	−0.08	0.09	0.97	−0.15	−0.02
ltc	−0.14	−0.05	0.12	−0.10	0.17	−0.32	0.00	0.05	0.70	−0.58
dash	−0.12	0.02	0.15	−0.09	0.12	−0.33	0.86	−0.17	−0.26	−0.04
maid	−0.28	0.34	0.16	0.87	−0.10	−0.08	0.00	−0.05	0.05	0.00
doge	−0.18	−0.02	0.32	−0.15	0.00	−0.65	−0.49	−0.11	−0.41	−0.01
xem	−0.74	−0.60	−0.25	0.06	−0.03	0.15	−0.01	−0.04	−0.07	−0.02
xmr	−0.18	0.11	0.49	−0.07	0.69	0.45	−0.09	−0.02	−0.13	−0.05
bts	−0.25	0.14	0.55	−0.30	−0.65	0.27	0.06	−0.03	0.13	0.03
Standard deviation	0.10	0.10	0.07	0.07	0.06	0.05	0.05	0.04	0.03	0.02
Proportion of Variance	0.26	0.24	0.12	0.11	0.08	0.07	0.05	0.03	0.03	0.01
Cumulative Proportion	0.26	0.50	0.63	0.74	0.82	0.88	0.93	0.97	0.99	1.00

Table 8: PCA of the crypto-currencies BTC, ETH, XRP, LTC, DASH, DOGE, MAID, BTS, XEM, XMR. Due to the late market entry of ETH and XEM, the reported results are based on an analysis starting in August 2015.

USD/GBP. This result hints that the findings by Eisl et al. (2015) and Briere et al. (2013) for BTC, may hold for other crypto-currencies, too.

3.5. The power law in crypto-currency returns

To investigate the evolution of the return dynamics of crypto-currencies from their emergence in the market as they mature, we study the power-law parameter of their absolute-returns distributions over time. We divide each time series of returns into periods of 90 days, compute the scaling parameter alpha per period for every crypto-currency in our dataset, and then average over the cross-section in the corresponding periods, taking into account the size of the crypto-currencies in terms of market value. For the definition of the power law and the specifications of the estimation, see Section A.3.

Figure 9 shows the results, partitioned into three distinct groups by mean market value. Thus the three alphas for period one display the means over all first periods of the crypto-currencies in the 3 respective groups. Clauset et al. (2009) state that α, referred to as the scaling parameter, typically lies in the range $2 < \alpha < 3$ for stocks. Interestingly, the mean over the alphas for the crypto-currencies in the first periods is higher than 3.

The mean alpha levels of group2 and group3 are less volatile than those of group1 with low-market-value crypto-currencies. Higher alpha implies a narrower distribution, i.e. more prevalence of lower absolute returns. Therefore, the higher alphas for the less successful crypto-currencies in terms of market

capitalizations in the first periods indicate that they show lower absolute returns compared to the other two groups. After the first year, the returns increase for group1, while the medium-value crypto-currencies show smaller absolute returns. After 1.5 to 2 years, the three groups converge to alphas as known from standard financial assets. Since the analysis is performed based on event time, common market shocks should not drive the results. Also, as shown before, movements of crypto-currency returns share little common variation.

For results about power-law parameters regarding the wealth distribution of crypto-currencies, see Li and Xiangjun (2017).

4. Conclusion

From the perspective of an investor into the alternative asset class of crypto-currencies, we document that returns of crypto-currencies are weakly correlated both in their cross-section as well as with established assets, and thus interesting investments for diversifying portfolios. An investment strategy based on the CRypto-currency IndeX (CRIX) bears lower risk than any single of the most liquid crypto-currencies.

Furthermore, we show that crypto-currencies exhibit a size effect like stocks. The market's deepening liquidity is accompanied by increases in market valuations. At the same time, the structure of the market has evolved over the past years. For instance, more crypto-currencies with comparatively smaller market valuations exist today.

We conclude that this still new alternative asset market can provide valuable contributions to portfolio allocation: crypto-currencies display high expected returns with large volatilities and at the same time remarkably low correlations with each other and with standard financial assets, allowing for diversification benefits. Thus, investors in alternative assets should keep a close eye on further developments in the crypto-currency market.

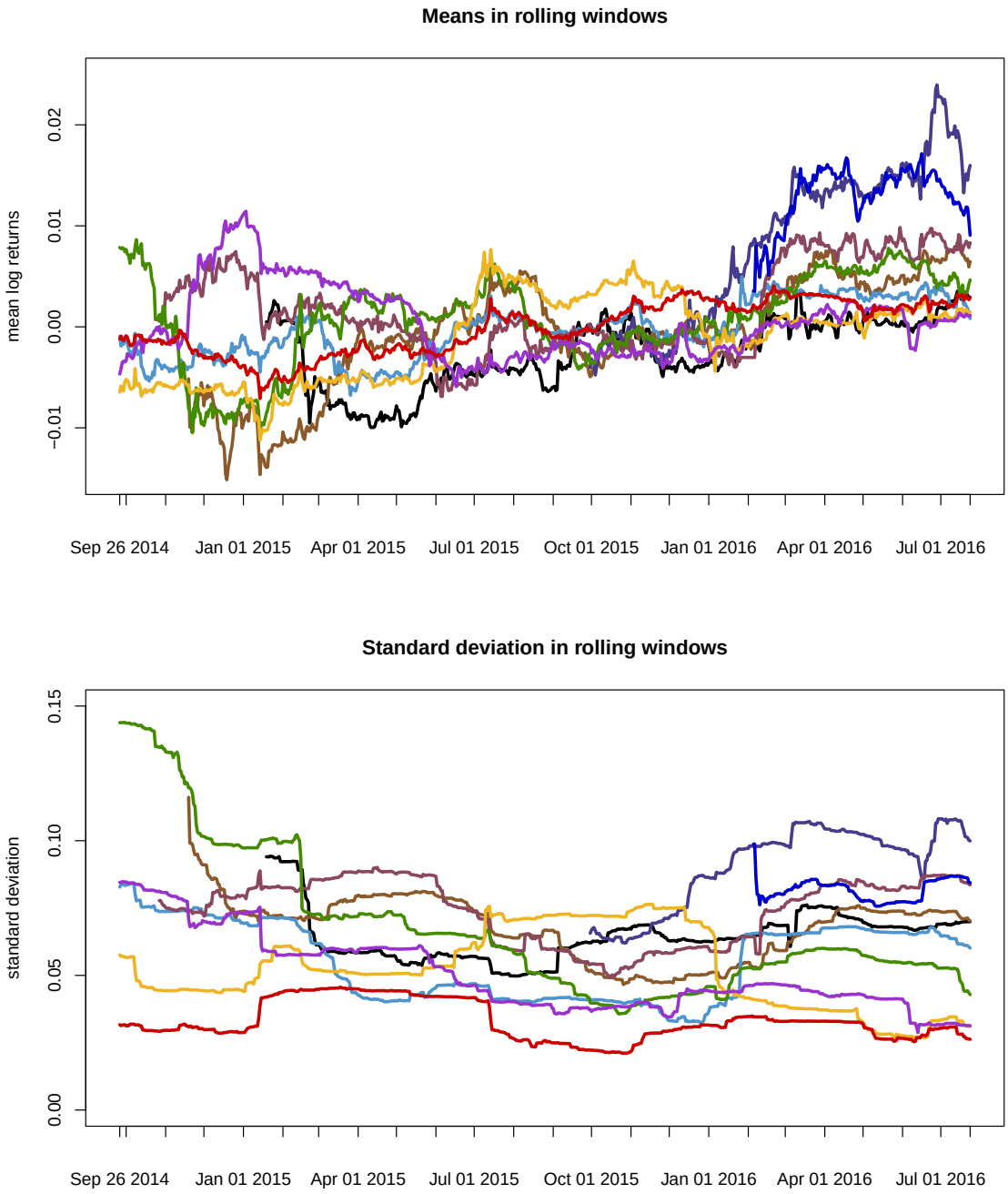

Figure 7: Calibrated parameters in rolling windows of 180 days. The upper panel displays means, the lower panel displays the standard deviations in the respective windows. Colors denote BTC, ETH, XRP, LTC, DASH, DOGE, MAID, BTS, XEM, XMR.

CCSMeansRollingWindow,SdRollingWindow Measures over time in rolling windows

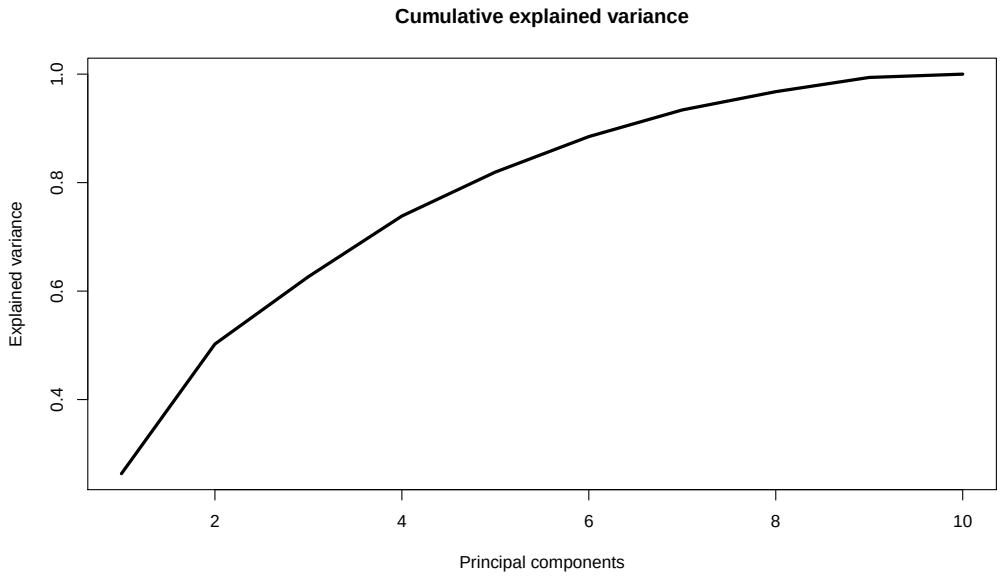

Figure 8: Representation of the cumulated fraction of explained variance by the PCA components of BTC, ETH, XRP, LTC, DASH, DOGE, MAID, BTS, XEM, XMR.

CCSPCAExVar

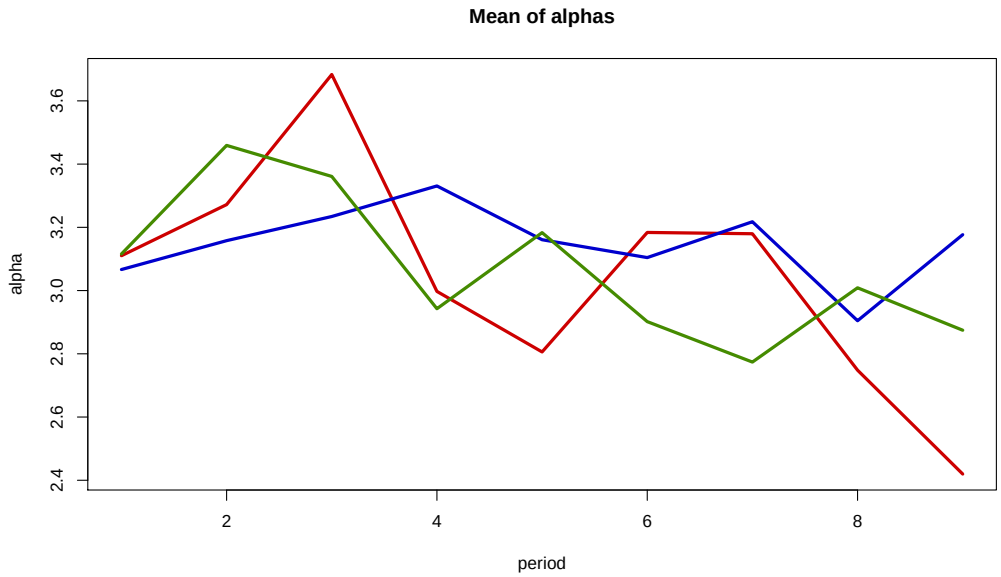

Figure 9: Power-law alphas of all crypto-currencies in the dataset, divided into 3 groups: Group1 has a mean market value $\leq$ 50,000 USD, group2 between 50,000 and 500,000 USD and group3 $>$ 500,000 USD. Crypto-currencies with daily trading volume $<$ 10 USD were excluded. Each alpha is calculated in time windows of 90 days.

CCSAlphas

A. Technical Appendix

A.1. Value at risk and expected shortfall

We calculate Expected Shortfall (ES) and Value-at-Risk (VaR) among our risk measures. Following Artzner et al. (1999) and Franke et al. (2015), the VaR is specified as follows:

Definition 1 *Given $\alpha \in (0,1)$, the VaR_α for a random variable X with distribution function $F(\cdot)$ is determined as*

$$VaR_\alpha(X) = \inf\{x | F(x) \leq \alpha\}.$$

ES is then determined as

$$\mathrm{E}\left[X | X > VaR_\alpha\right] \tag{1}$$

A common approach to determine (1) was investigated by McNeil and Frey (2000). They define $\{\varepsilon_t^{neg}\}_{t\in\mathbb{Z}}$ as a strictly stationary time series which represents the negative log returns of the underlying. It is assumed that the negative log returns follow the process

$$\varepsilon_t^{neg} = \mu_t + \sigma_t Z_t \tag{2}$$

with Z_t a strict white-noise process. They propose an ARMA-GARCH approach to obtain the realizations of Z_t.

Here, we employ a GARCH(1,1) model, defined as

$$\sigma_t^2 = \beta_0 + \beta\varepsilon_{t-1}^{2,neg} + \gamma\sigma_{t-1}^2$$

with $\beta_0 > 0$, $\beta, \gamma \geq 0$ and $\varepsilon_t^{neg} | (\varepsilon_{t-1}^{neg}, \sigma_{t-1}^2, \dots) \sim \mathrm{N}(0, \sigma_t^2)$.

A pseudo-ML approach is used to obtain the parameters of the model. Afterwards a threshold u is chosen and a General Pareto Distribution (GPD) is fitted to the data beyond this threshold. McNeil and Frey (2000) state that it is assumed that the tails begin with the threshold u. Hence the choice of u is critical for the analysis.

The GPD has the following distribution function, as given in McNeil and Frey (2000):

$$G_{\xi,\zeta}(z_t) = \begin{cases} 1 - (1 + \xi\frac{z_t}{\zeta})^{-1/\xi} & \xi \neq 0 \\ 1 - \exp(-\frac{z_t}{\zeta}) & \xi = 0 \end{cases}$$

where $\zeta > 0$, the support is $z_t \leq 0$ when $\xi \leq 0$ and $0 \geq z_t \geq -\frac{\zeta}{\xi}$ when $\xi < 0$. McNeil and Frey (2000) further show that for a random variable W with an exact GPD distribution with parameter $\xi < 1$ and ζ it can be shown that

$$\mathrm{E}\left[W | W > w\right] = \frac{w + \zeta}{1 - \xi},$$

where $\zeta + w\xi > 0$.

McNeil and Frey (2000) also show that in case the excesses of the threshold have exactly this distribution, it follows that

$$\mathrm{E}\left[Z_t | Z_t > z_{t,\alpha}\right] = z_{t,\alpha}\left(\frac{1}{1-\xi} + \frac{\zeta - \xi u}{(1-\xi)z_{t,\alpha}}\right)$$

with $z_{t,\alpha}$ as the $VaR_{t,\alpha}$, where t indicates dependence on time.

A.2. Portfolios

In order to contrast the results we find for investments into a single crypto-currency, we also perform the same analyses on portfolios of crypto-currencies. We consider three portfolios: first, an investment according to the market index CRIX, as well as two portfolios of investment into all crypto-currencies: one equally-weighted portfolio (EW), and one value-weighted (VW) by market capitalization.

The log returns on the equally-weighted portfolio are defined as the log return on an investment of equal amount into all crypto-currencies i, each yielding ε_{it}:

$$\epsilon_t^{EW} = \frac{1}{n}\sum_{i=1}^{n}\varepsilon_{it} \tag{3}$$

where n is the number of assets in the portfolio.

The value-weighted portfolio is constructed similarly to the CRIX index (Trimborn and Härdle, 2016). Denote by MV_{it} the market value of a single crypto-currency at time t; the log return on the value-weighted portfolio VW_t is then defined as the log return to a portfolio with invested amounts proportional to the MV_{it}:

$$\epsilon_t^{VW} = \frac{1}{\sum_{i=1}^{n} MV_{it}}\sum_{i=1}^{n} MV_{it}\varepsilon_{it} \tag{4}$$

A.3. Power Law

In Section 3.5 we investigated the behavior of groups of crypto-currencies (clustered by market capitalization) with a power-law analysis. Following Clauset et al. (2009), the definition of the probability density function of a power law in the discrete case is

$$p(x) = Cx^{-\alpha} \tag{5}$$

where x is the observed value, α the power law parameter and C a normalizing constant. Since the distribution would diverge at 0, a lower bound $x_{min} > 0$ has to be chosen. Solving for C, it follows

$$p(x) = \frac{x^{-\alpha}}{\zeta(\alpha, x_{min})}$$

with

$$\zeta(\alpha, x_{min}) = \sum_{i=0}^{\infty} (i + x_{min})^{-\alpha}$$

the Hurwitz zeta function, see Clauset et al. (2009).

To compute the αs, we use the R-package by Csardi and Nepusz (2006). x_{min} and α are computed as proposed by Clauset et al. (2009). We have not fixed x_{min}; it was chosen by comparing the p-values of a Kolmogorov-Smirnov test between the fitted distribution and the original sample, see Csardi and Nepusz (2006). x_{min} was chosen such that the p-value is largest. More details are in the cited articles.

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This research was supported by the Deutsche Forschungsgemeinschaft through the SFB 649 "Economic Risk".

EXHIBIT 18

Around the Block #4: on the recent market crash and Bitcoin's value proposition

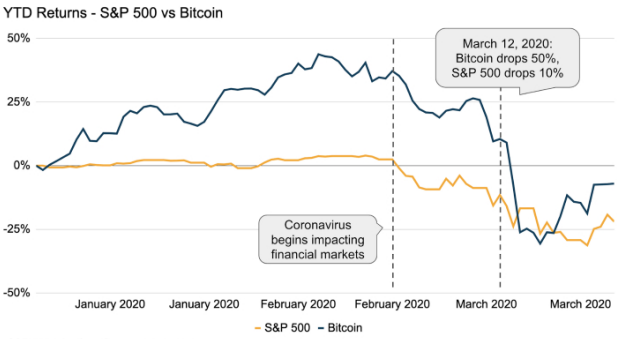
Coinbase Around the Block, sheds light on key issues in the crypto space. In this edition, we analyze recent market activity and Bitcoin's Value Proposition.

By Author **Around the Block**, March 30, 2020, 7 min read time

BTC and other crypto assets saw a ~50% price decline earlier this month on March 12, marking the single largest one-day drop in Bitcoin's price since 2013.

These moves coincided with broader financial market disruption amidst worries around the economic impact of COVID-19, with the S&P 500 and DOW Jones dropping nearly 10% in the biggest one-day slide since the Black Monday crash of 1987.

There is a growing belief in Bitcoin as a potential safe-haven amidst broader economic turmoil. But in this moment of validation and despite a widely held belief in Bitcoin as an uncorrelated asset, the Bitcoin market still crashed 50%. What's going on?



S&P 500 price from finance.yahoo.com

Putting context on the broader markets

We should first look at traditional financial markets for context. Just before March 12th, WHO declared the Coronavirus to be a pandemic, President Trump announced a 30-day travel ban between the United States and Europe, and Italy's Prime Minister placed the whole country on lockdown. As this growing recognition of the magnitude of COVID-19 sunk in, it became clear our global economy was not in a place to adequately handle the shock, and the markets suddenly reeled downward.

The psychology of this moment is important to understand. When investments sharply fall, investors naturally seek out "safe haven" assets — things that will not lose their value (usually USD). But everyone rushing to the exit at once produces a liquidity crisis, where the number of sellers far surpasses the number of buyers, which further drives prices lower and lower.

To add insult to injury, many large asset allocators held leveraged positions, where only $1 of real value was backing ~$2-$3 of borrowed value. When markets crashed, these leveraged positions were in jeopardy of becoming insolvent and being forced closed, further placing a premium on USD.

The general sell-off combined with a massive deleveraging event resulted in an intense rush for cash. In these moments, investors do not sell what they want to sell, they sell whatever they can. This includes Bitcoin and other cryptocurrencies, but every liquid market saw deep losses on March 12th.

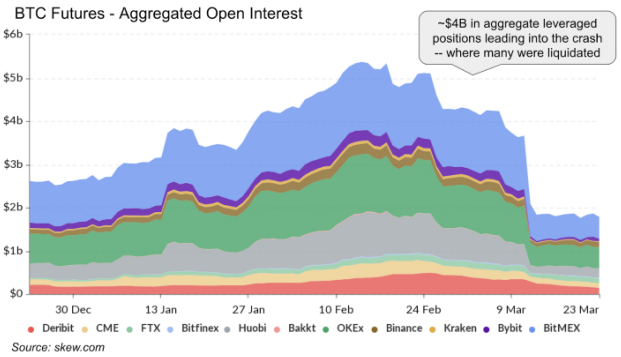
Let's talk Bitcoin. So what happened here?

The reasons behind the Bitcoin crash were similar. Some short term speculators sold, some institutions required cash for margin calls elsewhere, and some leveraged positions were forced to close. But it dropped harder and faster for Bitcoin than traditional markets for one central reason: the *size and scope of leverage* in the Bitcoin industry.

Traditional equities markets limit the amount of leverage to ~2–3x. In contrast, Bitcoin has some offshore exchanges that offer *100x+ leverage,* where $1 of Bitcoin could be used as collateral to back $100 in purchasing power. To be fair, this is very risky — a position leveraged to 100x would get force-closed if the market moved just ~1% against you. So most traders hold positions at a more sensible 5–30x leverage, but still notably higher than 2–3x.

Leverage also exists in several other products: miners often collateralize loans with Bitcoin, lenders offer cash loans for BTC deposits, and more advanced traders use leverage for futures contracts.

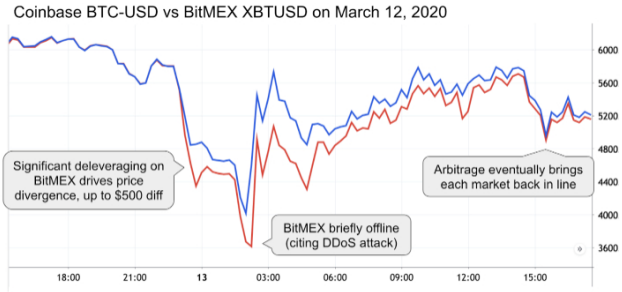
Prior to the crash, the aggregate size of all leveraged contracts on exchange-based products hovered around $4B. Significant enough that any appreciable drop could induce additional shocks to the price. Normally these drops coincide with willing buyers, but the March 12th panic flipped buyers into sellers. As prices drove lower, more leveraged positions were forced to close. Each new sell was met with tepid buying, dragging the price again lower, resulting in more liquidations. A cascading effect.



Source: skew.com

Cascading liquidations were most prominent on BitMEX, which offers highly leveraged products. Amidst the selloff, a Bitcoin on BitMEX was trading well below that of other exchanges. It wasn't until BitMEX went down for maintenance at peak volatility (citing a DDoS attack) that the cascading liquidations were paused, and the price promptly rebounded.

When the dust settled, Bitcoin had briefly spiked below $4000 and was trading around the mid $5000s.



Source: Tradingview.com

Some have argued that exorbitant leverage made accessible to retail investors in unregulated environments may be risky to the crypto asset class if left unabated. While it appears leverage played a role in crypto markets on March 12th, we should expect improvements to these dynamics as crypto matures, both externally from regulators increasing controls and internally from industry led initiatives.

If this was driven by a broad liquidity crisis, exacerbated by extreme leverage in crypto, then how did Coinbase customers react?

In the 48 hours during and immediately following the drop, we saw **record-breaking numbers** compared to our last 12-month averages:

- **5x increase** in cash and crypto deposits, totaling $1.3B
- **2x increase** in new-user signups
- **3x increase** in trading users
- **6x increase** in total traded volume

But beyond just a rush, two things are clear: **customers of our retail brokerage were *buyers* during the drop, and Bitcoin was the clear favorite.** Our customers typically buy 60% more than they sell but during the crash this jumped to 67%, taking advantage of market troughs and representing strong demand for crypto assets even during extreme volatility.

Bitcoin was most popular with over half of both total deposits and trades. Other cryptocurrencies also saw increased traction too, with ETH and XRP as #2 and #3 favored assets. Other popular assets included newer cryptocurrencies like Tezos and Chainlink, and older more established cryptocurrencies like Litecoin and Bitcoin Cash.

Coinbase Metrics on March 12-13, 2020*

	Total Volume	Number of Traders	Buy-Ratio
Bitcoin	6x increase	3.5x increase	69%

Ethereum	7x increase	5x increase	67% (+9% abs)
All Other Assets	7x increase	5x increase	65% (+1% abs)

** From coinbase retail brokerage (excludes Coinbase Pro); excludes crypto to crypto conversions; and metrics relative to last 12-month avgs*

Closing thoughts

For crypto enthusiasts, it's harrowing to watch the price ripple downward and shake through the industry. In these moments, it's only human to second guess our convictions. Perhaps you felt the same.

But with some context, we can recognize there are broader mechanisms at play. Fear drove many investors to cash and induced a deep liquidity crunch (cash became "expensive"), decoupling price from fundamental value and leading to broad deleveraging in nearly all asset classes. Bitcoin was not spared, and in fact was hit hardest due to the size and scope of deployed leverage, leading to a fierce cascade of liquidations.

Since the drop, Bitcoin and the broad cryptocurrency ecosystem has rallied while equities have continued to drop (S&P -6% vs Bitcoin +23% as of March 27th). Coinbase customers in particular exemplified this buy behavior during the drop and thereafter.

This has happened before. In the 2008 financial crisis, gold initially dropped more than 30%. Not because it's a bad store of value, but because a similar liquidity crisis affected gold just as well. Gold went on to rally 3x over the next three years as its value stood out amidst the broader financial turmoil.

Price of Gold 2007-2009

Gold prices sourced from https://sdbullion.com

Bitcoin was created for a moment like this. Inscribed into its Genesis Block is the phrase "Chancellor on brink of second bailout for banks," an homage to the government bailouts of 2008 and the last great financial crisis. The call out is a subtle nod to the need for a sovereign form of money without any central intermediary. And as the US government turns to slashing interest rates, passing large stimulus packages, and infinite quantitative easing, Bitcoin will soon do the opposite in the next Bitcoin halving. The contrast could not be more stark.

For many, Bitcoin is the hardest form of currency that exists. Only 21 million will be issued, and the network is collectively owned and controlled by its participants with no central authorities who can affect the supply schedule or adjust interest rates. Ultimately, Bitcoin's value prop should not be defined by extraneous market dynamics, but rather by its unique properties that make it a potentially attractive store of value.

To participate in the emerging cryptoeconomy, sign up for Coinbase today.

For more reading:

- Fred Wilson muses about correlation and market meltdowns, with a section on crypto
- Multicoin's technical analysis of what drove the dip
- Anthony Pompliano of Morgan Creek Digital posts a salient commentary

###

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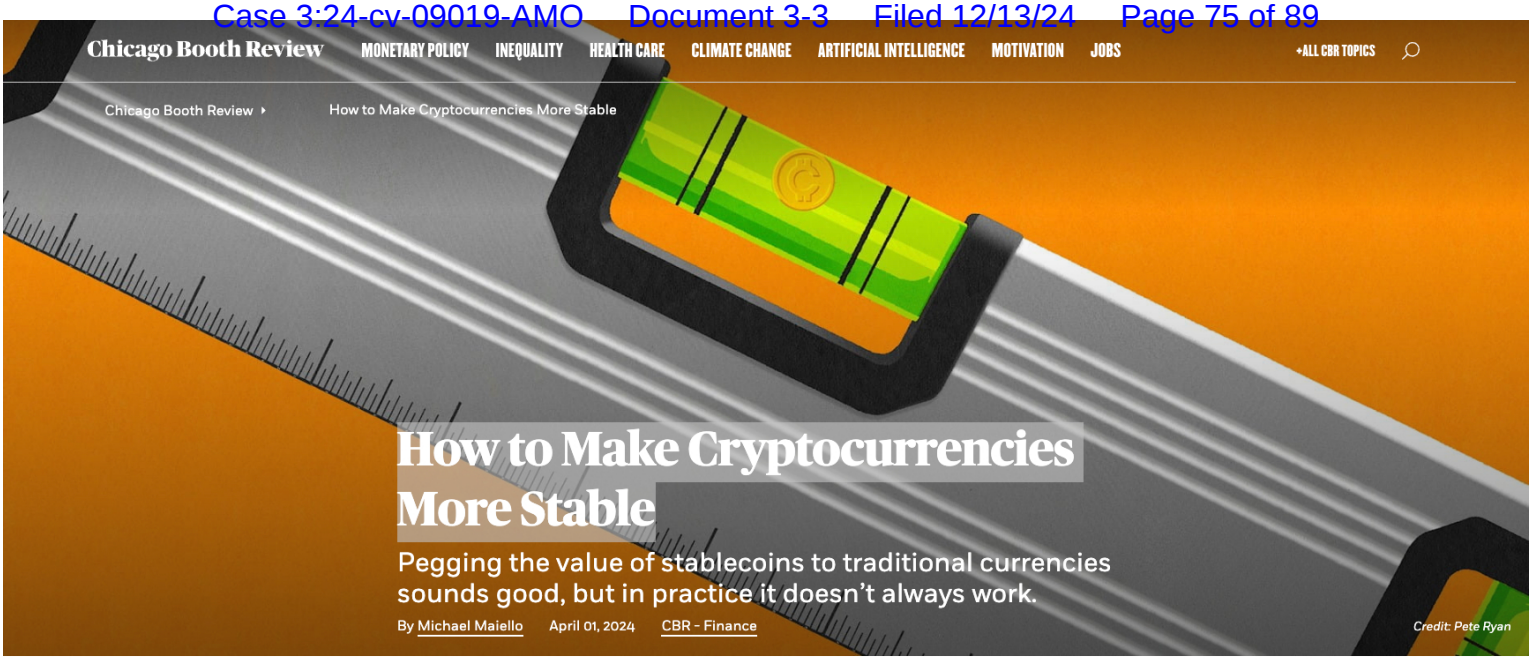


How to Make Cryptocurrencies More Stable

Pegging the value of stablecoins to traditional currencies sounds good, but in practice it doesn't always work.

By Michael Maiello April 01, 2024 CBR - Finance

Credit: Pete Ryan

Since the debut of Bitcoin in 2009, two things have become clear. One is that cryptocurrencies are wildly unstable. There's even a website called bitcoinrollercoaster.com. The other is that digital currencies are coming, like it or not.

Stablecoins represent an effort to ameliorate the volatility associated with cryptocurrencies such as Bitcoin, Ethereum, and Dogecoin by turning cryptos into proxies for the fiat currencies issued by official central banks. But in the pursuit of maintaining stability, the issuer has to manage the price impact of demand shocks, suggests research by Stockholm School of Economics' Adrien d'Avernas, HEC Paris's Vincent Maurin, and Chicago Booth's Quentin Vandeweyer.

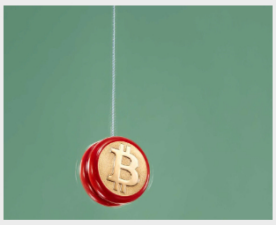
Stablecoins such as Tether, USD Coin, Binance, and TerraUSD became popular quickly, surging from $3 billion issued worldwide in 2019 to $125 billion in 2023. But values also fell in the 2022 crypto bear market, tarnishing the reputation of stablecoins. When TerraUSD prices crashed that May, investors were wiped out. Cryptocurrency exchange FTX had been working on creating a stablecoin before the exchange failed and its founder Sam Bankman-Fried was convicted of fraud and conspiracy.

The researchers sought to better understand the dynamics of algorithmic stablecoins, or those that are entirely digital, with no tangible collateral as backing. The fundamental aim of an algorithmic coin, the study explains, is to maintain a price equal to 1 (one coin equals $1, say). For that to happen, the issuer has to make sure that supply and demand stay balanced.

If demand rises, the issuer can address that cheaply and easily by issuing more stablecoins. The bigger challenge is falling demand, in which case the issuer needs to buy back coins. To do so, it offers digital tokens that can be exchanged for stablecoins at designated times in the future, once the price recovers. For an example, say demand weakens and the price falls to 90 cents. Buybacks return the coin's value to $1, and the sellers receive tokens. Demand then strengthens and pushes the coin's value to $1.10, and the token holders cash in their reserve assets for newly minted coins that push the price back to $1.

In this way, these two intangible assets—a stablecoin and its associated token—may look like levers on a perpetual machine, Vandeweyer says. If the market functioned perfectly as designed, an issuer could work both levers in order to keep prices stable

Recommended Reading



Is Crypto's Volatility Bad for the Financial System?

Economists consider the roots and possible consequences of crypto's ups and downs.
CBR - Clark Center Panels

Stephen Colbert Was Wrong on Bitcoin

Surveys provide a snapshot of the 12 percent of Americans who own cryptocurrencies.
CBR - Finance

The model is somewhat similar to that of a central bank, which absorbs bonds and offers reserves to help maintain prices. Coordinated confidence in the system's ability to stay pegged to $1 is crucial to its success. "If everyone believes that they are in a stable equilibrium, then you're going to behave as though it is stable," says Vandeweyer. If investors lose confidence in the system, that is a self-fulfilling prophecy, and the stablecoin's price falls to zero.

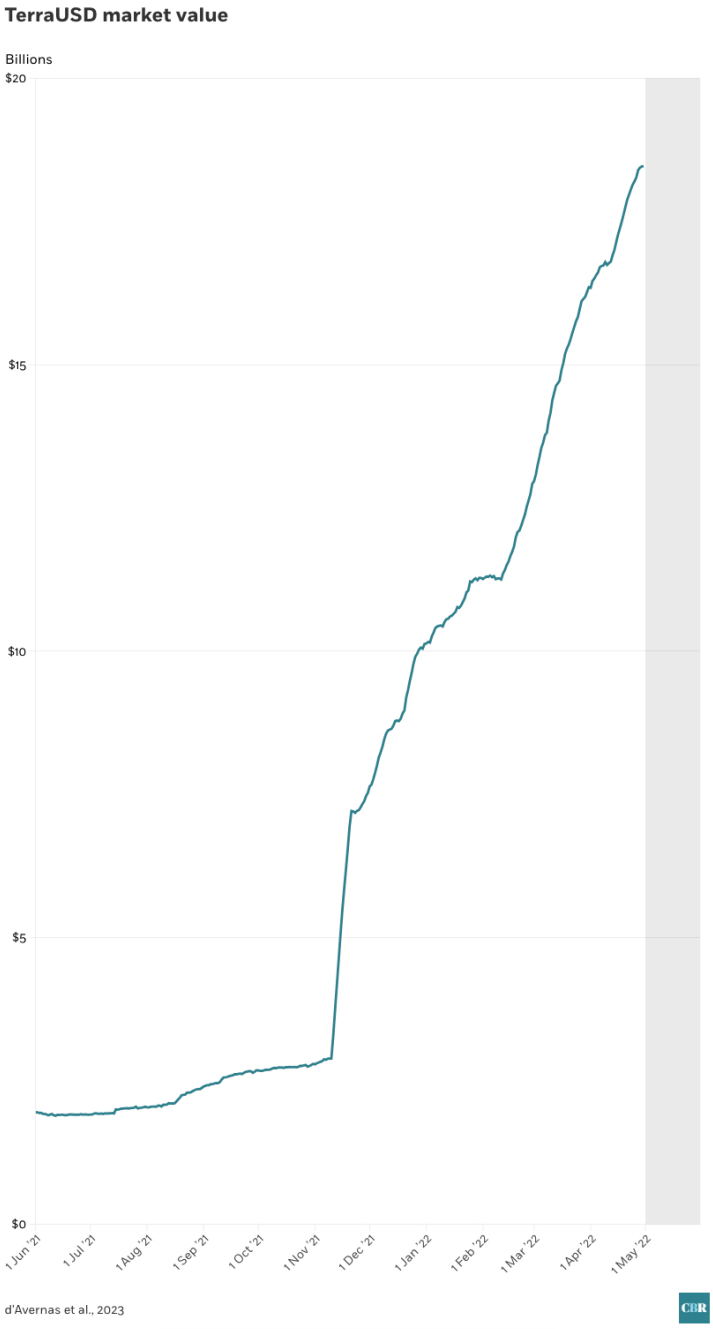
But confidence alone cannot keep a price stable, the researchers write. Mathematically speaking, the issuer has to be able to overcome a large drop in demand, and the key to that is the equity token's value, which reflects the issuer's anticipated profitability. (The tokens are much like shares of stock, whose price reflects anticipated corporate profits.) Say there are 1 million stablecoins trading, and the equity tokens have a market capitalization of $500,000. If the coin's price fell from $1 to 40 cents—maybe due to the actions of a competitor, regulator, or short-seller—the value of an equity token would likely also fall. The issuer could create more equity tokens to buy back coins, but it might not be able to create enough to save its skin. If the value of the additional tokens were to fall to zero, it would be impossible for the issuer to repurchase enough stablecoins to maintain a $1 peg.

This, the researchers posit, is consistent with what happened during the TerraUSD collapse, which took with it about $45 billion in value. In its wake, only a few smaller algorithmic stablecoins remain.

Some stablecoins are partially or entirely collateralized, the researchers say, which mitigates the risk of a large demand shock but doesn't solve all problems. For instance, sharp price movements could hit both collateral and coin value at the same time, says Vandeweyer. Such is the case with USD Coin in that it was partially backed by debt securities issued by Silicon Valley Bank, which failed in March 2023.

A necessary condition for eliminating this risk, they write, is to fully collateralize a stablecoin, as some regulators including the Securities and Exchange Commission have proposed. If $1 million stablecoins were trading, the issuer would keep $1 million in cash as reserves. But for there to be any profit potential for the issuers, the stablecoins would need to be more valuable than their cash counterparts—which can happen, for example if traded by people in countries that have poorly managed currencies and where it is difficult to get access to US dollars.

The collapse of an algorithmic stablecoin



Prior to May 2022, Terra was one of the fastest-growing stablecoin platforms. TerraUSD, the platform's algorithmic stablecoin pegged to the US dollar, reached a peak market value of close to $20 billion.

TerraUSD maintained its peg by allowing users to exchange one unit of TerraUSD for $1 of LUNA, the platform's cryptocurrency, whenever the stablecoin deviated from its peg. This mechanism of "burning" TerraUSD and "minting" LUNA, and vice versa, allowed Terra to regulate the stablecoin's supply and maintain its value.

But in May 2022, loss of confidence in Terra precipitated the mechanism's collapse. The platform tried to defend TerraUSD's peg by burning about 8 billion of TerraUSD . . .

. . . and minting LUNA at an exponential pace.

This massive issuance drove LUNA's price to zero . . .

. . . yet could not reanchor TerraUSD to its peg.

Works Cited

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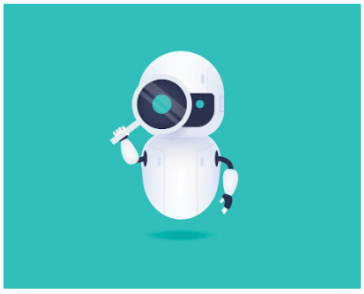

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EXHIBIT 20

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Wrapped Bitcoin Price (WBTC)
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Wrapped Bitcoin Price (WBTC)

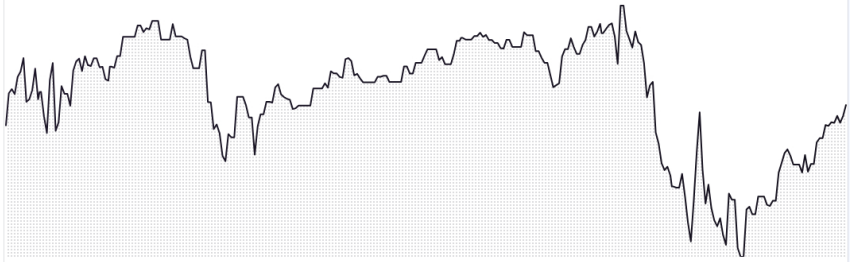
USD Search assets

WBTC Price

$96,442.52

↗ $243.09 (0.25%)

1H 1D 1W 1M 1Y ALL



5:10 PM 8:20 PM 11:30 PM 2:40 AM 5:50 AM 9:00 AM 12:10 PM 3:20 PM

Last updated: 4:19 PM, Dec 10, 2024

Market stats

Wrapped Bitcoin is on the rise this week. ↗

The price of Wrapped Bitcoin has increased by 0.64% in the last hour and increased by 0.32% in the past 24 hours. Wrapped Bitcoin's price has also risen by 0.50% in the past week. The current price is $96,442.52 per WBTC with a 24-hour trading volume of $730.09M. Currently, Wrapped Bitcoin is valued at 6.95% below its all time high of $103,645.91. This all-time high was the highest price paid for Wrapped Bitcoin since its launch.

The current circulating supply of Wrapped Bitcoin is 136,435.974 WBTC which means that Wrapped Bitcoin has as total market cap of 136,435.974.

OVERALL		PRICE CHANGE		1 YEAR BENCHMARKS	
MARKET CAP	VOLUME (24H)	1 HOUR	1 DAY	PERFORMANCE	VS. MARKET
$13.1B	$730.1M	↗ 0.64%	↗ 0.32%	↗ 120.35%	↗ 4.18%
CIRCULATING	HOLD TIME	1 WEEK	2 WEEKS	VS. BTC	VS. ETH
136.4K WBTC	12 days	↗ 0.5%	↗ 3.6%	↘ 0.3%	↗ 41.47%
POPULARITY	ALL TIME HIGH	1 MONTH	1 YEAR		
#10120	$103,645.91	↗ 20.02%	↗ 121.85%		

About Wrapped Bitcoin

Wrapped Bitcoin (WBTC) is an Ethereum token that is intended to represent Bitcoin (BTC) on the Ethereum blockchain. It is not Bitcoin, but rather a separate ERC-20 token that's designed to track Bitcoin's value. WBTC was created to allow Bitcoin holders to participate in decentralized finance ("DeFi") apps that are popular on Ethereum. Through a WBTC partner, 1 Bitcoin can be exchanged for 1 Wrapped Bitcoin, and vice-versa. The BTC that backs WBTC is verifiable through a "proof of reserve" system that verifies the 1:1 backing between minted WBTC tokens and Bitcoin stored by custodians. WBTC is maintained by a group called the WBTC DAO that consists of over 30 members. It was originally started by BitGo, Ren, and Kyber.

Whitepaper Official website

What is Wrapped Bitcoin?

Wrapped Bitcoin (WBTC) is a tokenized version of Bitcoin (BTC) that operates on the Ethereum (ETH) blockchain. It adheres to the ERC-20 standard, which is the basic compatibility standard of the Ethereum blockchain. This compatibility allows WBTC to be fully integrated into Ethereum's ecosystem, including decentralized exchanges, crypto lending services, prediction markets, and other ERC-20-enabled decentralized finance (DeFi) applications. WBTC is backed by Bitcoin at a 1:1 ratio through a network of automatically monitored merchants and custodians. This aims to ensure that its price is pegged to Bitcoin and allows users to transfer liquidity between the BTC and ETH networks in a decentralized and autonomous manner.

How does Wrapped Bitcoin work?

The creation of Wrapped Bitcoin brings Bitcoin into the world of Ethereum's DeFi ecosystem. When users want to convert BTC into WBTC, the to-be-converted BTC is held by a custodian, who participates in the actual minting and burning of Ethereum-based tokens. When WBTCs are burned, the user can reclaim their BTC balance from the custodian. During minting, users send BTC to the custodian for storage and receive an equivalent in WBTC tokens. The user who wants to swap between WBTC and BTC performs a trade to move funds to the merchant. Once finalized, the user can use their BTC/WBTC as they see fit. If WBTC is converted to BTC, the associated Wrapped Bitcoin balance will be destroyed through a burn transaction.

What are the potential use cases for Wrapped Bitcoin?

As Wrapped Bitcoin tokens adhere to the ERC-20 token standard, they can be used across the broader Ethereum ecosystem. This includes trading them on decentralized exchanges and exploring decentralized finance opportunities through protocols and platforms supporting WBTC. DeFi opportunities for WBTC range from lending and borrowing to yield farming, token swapping, and liquidity pools. Various protocols and platforms support Wrapped Bitcoin. Using WBTC as collateral for a crypto-backed loan can be an option for businesses. Additionally, WBTC holders may receive compensation from supplying liquidity. Another potential use case for WBTC is in margin trading, where Wrapped Bitcoin may be used to trade Ethereum, stablecoins, and other ERC-20 tokens.

What is the history of Wrapped Bitcoin?

Wrapped Bitcoin was first announced on October 26, 2018, and officially launched on January 31, 2019. The Wrapped Tokens project, of which WBTC is a part, is a joint project of three organizations: BitGo, Kyber Network, and Ren. BitGo, co-founded in 2013 by American computer scientist and entrepreneur Mike Belshe, is an institutional digital asset custody, trading, and financial services firm. Kyber Network is an on-blockchain liquidity protocol that enables the integration of different cryptocurrency tokens and DeFi applications. It was founded in 2017 by Loi Luu, Victor Tran, and Yaron Velner. Ren is a company focused on cross-blockchain integration of cryptocurrency assets and DeFi applications via solutions such as RenBridge, RenVM, and

others. It was founded in 2017 by Taiyang Zhang and Loong Wang.

Wrapped Bitcoin Price History

Date	Price	Change
Today (December 10, 2024)	$96,442.52	0.25%
24 hours ago (December 9, 2024)	$96,199.43	0.32%
1 week ago (December 3, 2024)	$95,756.26	0.50%
1 month ago (November 10, 2024)	$79,771.15	20.02%
1 year ago	$43,767.16	121.85%

Wrapped Bitcoin Calculator

How much is 1 WBTC?

CONVERSION TABLE

1 Wrapped Bitcoin (WBTC) to United States Dollar (USD)	$96,442.52	1 Wrapped Bitcoin (WBTC) to Canadian Dollar (CAD)	CA$136,675.70
1 Wrapped Bitcoin (WBTC) to British Pound (GBP)	£75,568.74	1 Wrapped Bitcoin (WBTC) to Japanese Yen (JPY)	¥14,660,130.26
1 Wrapped Bitcoin (WBTC) to Indian Rupee (INR)	₹8,185,441.11	1 Wrapped Bitcoin (WBTC) to Real (BRL)	R$584,033.37
1 Wrapped Bitcoin (WBTC) to Euro (EUR)	€91,681.22	1 Wrapped Bitcoin (WBTC) to Nigerian Naira (NGN)	NGN 151,149,197.81
1 Wrapped Bitcoin (WBTC) to South Korean Won (KRW)	₩138,235,634.63	1 Wrapped Bitcoin (WBTC) to Singapore Dollar (SGD)	S$129,436.43

View more — Last update: 4:19 PM

FAQ

What is the current price of Wrapped Bitcoin?

We update our Wrapped Bitcoin to USD currency in real-time. Get the live price of Wrapped Bitcoin on Coinbase.

What is the market cap of Wrapped Bitcoin?

The current market cap of Wrapped Bitcoin is $13.15B. A high market cap implies that the asset is highly valued by the market.

What is the all time high of Wrapped Bitcoin?

The all-time high of Wrapped Bitcoin is $103,645.91. This all-time high is highest price paid for Wrapped Bitcoin since it was launched.

What is the 24 hour trading volume of Wrapped Bitcoin?

Over the last 24 hours, the trading volume of Wrapped Bitcoin is $730.09M.

What other assets are similar to Wrapped Bitcoin?

Assets that have a similar market cap to Wrapped Bitcoin include Avalanche, Dogecoin, Wrapped TRON, and many others. To see a full list, see our comparable market cap assets.

How many Wrapped Bitcoin are there?

The current circulating supply of Wrapped Bitcoin is 136 thousand.

What is the typical holding time of Wrapped Bitcoin?

The median time that Coinbase customers hold Wrapped Bitcoin before selling it or sending it to another account or address is 12 days.

What is the relative popularity of Wrapped Bitcoin?

Wrapped Bitcoin ranks 138 among tradable assets on Coinbase. Popularity is currently based on relative market cap.

What is the current trading activity of Wrapped Bitcoin?

Currently, 92% of Coinbase users are buying Wrapped Bitcoin. In other words, 92% of Coinbase customers have increased their net position in Wrapped Bitcoin over the past 24 hours through trading.

Can I buy Wrapped Bitcoin on Coinbase?

Yes, Wrapped Bitcoin is currently available on Coinbase's centralized exchange. For more detailed instructions, check out our helpful how to buy Wrapped Bitcoin guide.

Social

Some highlights about Wrapped Bitcoin on social media

530 unique individuals are talking about Wrapped Bitcoin and it is ranked #374 in most mentions and activity from collected posts. In the last 24 hours, across all social media platforms, Wrapped Bitcoin has an average sentiment score of 4 out of 5. Finally, Wrapped Bitcoin is becoming more newsworthy, with 0 news articles published about Wrapped Bitcoin. This is a 0% increase in news volume compared to yesterday.

On Twitter, people are mostly neutral about Wrapped Bitcoin. There were 21.11% of tweets with bullish sentiment compared to 2.01% of tweets with a bearish sentiment about Wrapped Bitcoin. 76.88% of tweets were neutral about Wrapped Bitcoin. These sentiments are based on 199 tweets.

On Reddit, Wrapped Bitcoin was mentioned in 16 Reddit posts and there were 30 comments about Wrapped Bitcoin. On average, there were more upvotes compared to downvotes on Reddit posts and more upvotes compared to downvotes on Reddit comments.

Powered by LunarCrush

Overview

CONTRIBUTORS — POSTS — DOMINANCE — VOLUME RANK

530 people | 110 posts | 0.03% | #374

AVERAGE SENTIMENT
4 out of 5

Twitter

TWEET COUNT
199 people

SENTIMENT
21.11% Bullish | 76.88% Neutral | 2.01% Bearish

Reddit

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A selection of cryptocurrencies in the top 50 by market cap.

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Comparable market cap

Of all the assets on Coinbase, these 12 are the closest to Wrapped Bitcoin in market cap.

Avalanche	Dogecoin	Wrapped TRON	TRON
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A selection of other relevant cryptocurrencies

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